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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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NOTES AND COMMENTS.

The Influence of Poor Coke on Cupola Working.

At the opening meeting of the Lancashire Branch of the Institution of British Foundrymen, it was generally conceded that for some considerable time most foundries have experienced the difficulties arising from obtaining alternate supplies of good and poor coke, with occasional loads of absolute rubbish, and the vast influence which this state of affairs has been found to have upon the castings made, whether in grey or malleable cast-iron.

One of our correspondents suggests that "A good coke should be strong, compact and fairly heavy even when perfectly dry, and should contain not over 6 per cent. of ash and about 0.6 per cent. sulphur. On the other hand, a typical poor coke is weak, more or less open in texture, contains patches of clinker, and may have 12 per cent. of ash and 1.2 per cent. of sulphur, or even more."

It is interesting to examine what actually happens to the working of the cupola in the case of such cokes. On the face of it, since the carbon in the coke is the fuel, and a poor coke contains a smaller percentage than a good coke, then a slightly larger quantity of coke than usual should put matters right. Actually the influence of the poor coke is much deeper.

A cupola using good coke will take a fixed quantity of fuel, iron and limestone, and will burn away so that the iron will always melt in the correct zone. Also the blower or fan is regulated to supply air in the proper quantity and at the correct pressure. On using a poor coke it is immediately found that the iron is not sufficiently hot, and more coke is added per charge. The coke, being somewhat loose in texture, becomes compressed, and slightly chokes the furnace, whilst the melting zone is usually raised a little higher owing to the greater bulk of the coke. For the same reason, fewer charges can be put on at a time, and melting is slower.

Then the higher ash content in the coke demands more limestone as flux, resulting in more slag and still further choking the furnace—also necessitating the more frequent opening of the slag-hole. Incidentally, more fuel will be needed to keep the extra slag in a molten state.

The higher sulphur content is yet another problem. If a suitable grade of iron is turned out with good coke, then how is the quality to be maintained whilst using the poor coke? When the foundry manager finds the solution to this query, half his troubles will vanish. What actually happens is that most of the sulphur in the coke goes into combination with the iron, so that if a poor coke contains more sulphur than the good coke, then the castings will also contain more sulphur. This will naturally make grey iron harder and more difficult to machine, and malleable castings more difficult to anneal. Something may be done by increasing the manganese and limestone in the charge, but the latter procedure is doubtful in its results, causing still more slag and more difficulty in working the furnace.

Still another point is that, owing to the higher melting zone, lower temperature and more oxidising conditions in the cupola whilst using poor coke, the silicon content of the iron is generally reduced, which, of course, works hand in hand with the higher sulphur content to cause hardness troubles.

Thus it will be seen that the value of a coke bears, not a simple, but a most complex relationship to its carbon content, and this must be kept in mind when purchasing so-called "cheap" coke, which often turns out to be extremely dear.

It is worthy of mention that none of the better-known works on the metallurgy of cast iron contains representative analyses of foundry coke. Whilst Campbell, the American metallurgist, states that blast furnace coke should have less than 12 per cent. of ash and less than 1 per cent. of sulphur, analyses of seven brands in our possession show that in No. 1 brand the ash diminished from 10.1 to 9.3 per cent. in eight years, but the sulphur increased from 1.00 to 1.40 per cent. In No. 2 brand the sulphur rose from 1.0 to 1.4 per cent., and the ash from 10.6 to 14.25 in four years. No. 3 remained fairly constant over a period of four years, averaging 0.92 per cent. sulphur and 10 per cent. ash. Of the four remaining brands, none would comply with Campbell's specification as regards sulphur, but two would pass as regards ash.

ROYAL CHARTER.

We are officially informed that a Royal Charter has been granted to the Institution of British Foundrymen.

International Foundry Trades' Exhibition.

Duke of York Invited.

The Birmingham Chamber of Commerce on Monday finally approved of the Committee of Management in connection with the International Foundry Trades' Exhibition to be held at Bingley Hall, Birmingham, from June 15 to June 24 next year. Lord Weir is the President, and the Executive Council was elected as follows:—Mr. H. Lakin-Smith (chairman), Messrs. H. C. Field, M.A., J. P. Achurch, Alderman J. B. Burman, W. Deakin, G. C. Vyle, H. O. Warrall, W. Mills, J. E. Fletcher, H. E. Weeks, C. Heggie, W. C. Oubridge, D. M. Wood, H. E. Parkes, J. Percy Plant, G. Turner, L. W. Gould, J. Weatherhead, F. Higginbotham, T. Vickers, C. Petallack, V. C. Faulkner, H. H. Moore, H. L. Reason, H. Cole Estep (representing America), Emile Ramas (France), and J. Leonard (Belgium). The Technical Committee comprises Mr. J. E. Fletcher (chairman), Colonel W. F. Cheesewright, Messrs. H. Field, F. J. Cook, W. J. Foster, J. T. Goodwin, C. Heggie, D. Lewis, W. P. Parker, C. B. Pugh, H. L. Reason, C. Scarpton, D. M. Wood, E. A. Smith, E. N. Wright, and E. Miller.

The headquarters of the Management Committee will be the Birmingham Chamber of Commerce, New Street, Birmingham. It is intended to ask the Duke of York to formally open the Exhibition, and there is every probability that his Royal Highness will accept the invitation.

The enterprise has been taken up with great enthusiasm, all the space for exhibitors has been applied for, and it is expected that the exhibits will number at least three hundred. American displays will have considerable prominence, and Belgium and France will be well represented.

The Determination of Phosphorus in Brass.

By F. A. LIVERMORE.

Thirteen grams of the metal are dissolved in 100 HNO_3 (s.g. 1.2). The excess acid is evaporated off and the solution, diluted to 100 ccs. with water, is made nearly neutral with ammonia; 20 c.c.s. of ammonium nitrate solution (340 grams NH_4NO_3 per litre) and 10 c.c.s. of HNO_3 (25 per cent. solution) are added. The whole is heated to nearly boiling, and from a separating funnel, with constant shaking, 15 c.c.s. of hot 3 per cent. ammonium molybdate solution are added and the shaking continued for about two minutes. The precipitate is allowed to stand for 20 minutes. It is then filtered off by decantation and washed with 50 c.c.s. of wash liquid (composed of 200 grams NH_4NO_3, 160 c.c.s. HNO_3 (s.g. 1.42), 4,000 c.c.s. water, and freed from copper with the least possible quantity of water. The precipitate is dissolved back into the original beaker with 10 c.c.s. of 8 per cent. NH_4OH; 20 c.c.s. NH_4NO_3, 30 c.c.s. of water, and 1 c.c. ammonium molybdate are added. The solution is heated nearly to boiling, and 20 c.c.s. of 25 per cent. HNO_3 are added with vigorous shaking. Again shake for two minutes and allow to stand for 20 minutes. The precipitate is filtered off, washed with 2 per cent. HNO_3, and washed off into a weighed glass evaporating dish, evaporated over a water bath, and finally dried in a steam oven until constant in weight. The precipitate is weighed as ammonium phospho-molybdate.

Factor to phosphorus = 0.0163.

Shmits's Method.—If the phosphorus is present in considerable quantity it is advisable to proceed as follows:—The ammonium phospho-molybdate is dissolved in warm 2.5 per cent. ammonia, after which dilute HCl is added until the yellow precipitate dissolves with difficulty. An excess of slightly acid solution of magnesia mixture is added, and the solution is heated to boiling. A few drops of phenol pthalein solution are added, and 2.5 per cent. ammonia solution is added from a separating funnel as quickly as possible with continuous stirring until the liquid becomes slightly pink in colour. The solution is allowed to cool and one-fifth of its volume of ammonium hydrate (s.g. 0.88) is added, and the whole thoroughly stirred. After about two hours the precippitate of magnesium ammonium phosphate is filtered off, washed well with water, dried and ignited. The ignited $Mg_2P_2O_7$ should be treated with two or three drops of HNO_3 (s.g. 1.42), and again ignited. This is repeated until the residue is pefectly white. The following table shows the amount of reagents used for varying amounts of phosphorus present for the earlier precipitations:—

Present in	Am. Molybdate	Am Nitrate	Nitric acid.
	ccs.	ccs.	ccs.
0.1	120	30	20
0.01	15	20	10
0.005	15	20	10
0.002	10	15	5
0.001	10	15	5

Foundry Queries.

Chilled Rolls.

U.1.—Some chilled rolls I have to make are 8 in. dia. by 12 in. long, and are required to be very hard when finished. Could you recommend a suitable mixture of iron for this purpose? The brands stocked by us are Carron No. 1, Thorncliffe cylinder and Eglinton No. 1 pig-iron. I thought by making a mixture of the two former with hard scrap a satisfactory result might be obtained.—"CHILLED ROLLS."

U.2.—If our correspondent has had no lengthy experience in making chilled rolls he is facing a big proposition. If there is any part of the cast-iron industry where methods of production are jealously guarded it is the making of chilled rolls, but given sound practical knowledge in chill-castings work any foundryman can make as good a roll as many old-established firms who make to so-called secret specifications; but considerable care, skill and experience are needed to get really good results. Close-grained grey-irons must be used for obtaining hard rolls. Mixtures of several brands of cold-blast pig-iron from Staffordshire, Shropshire or Blaenavon are standard practice. To obtain strength and hardness is not an easy matter. The strength depends upon the proportions of carbon and phosphorus, and the depth of chill is influenced by the amount of silicon and sulphur present; high sulphur increasing the depth of chill. A composition which has given good results is as follows:—Silicon, 0.50; sulphur, 0.12; phosphorus, 0.08; manganese, 0.30; total carbon, 2.40. This metal is particularly adapted for the making of rolls resistant to abrasion and wear. The British Cast-iron Research Association are now employed upon thorough research upon chilled roll production, and their investigations should remove many of the troubles incidental to this trade.

Publications Received.

THE WHITING CORPORATION, HARVEY, ILL., U.S.A.—"Whiting Cranes."

"THE JOURNAL OF INDUSTRIAL WELFARE," November, 1921. Price 9d. 51, Palace Street, Westminster, S.W.1.

"THE DROP FORGER," November, 1921. Price 1s. Published by the Association of Drop Forgers and Stampers, 48, Newhall Street, Birmingham.

"BULLETIN OF THE CLEVELAND TECHNICAL INSTITUTE," October, 1921.—Mr. Edward L. Johnson, Secretary, Corporation Road, Middlesbrough.

MESSRS. G. A. HARVEY & COMPANY (LONDON), LIMITED, Woolwich Road, London, S.E.7.—"Mild Steel Transformer Tanks," and "Steel Equipment."

MESSRS. DANIEL ADAMSON & COMPANY, LIMITED, Dukinfield, near Manchester. "Cheap Power," an illustrated descriptive catalogue of the firm's specialties in power appliances for traction, lighting, and industrial supply.

"THE BULLETIN OF THE BRITISH ENGINEERS' ASSOCIATION." Special Conference number, October, 1921. This issue of the publication gives a statement on "The Problem of Restoring Vitality to the Engineering Industry." The Secretary, British Engineers' Association, 32, Victoria Street, London, S.W.1.

Baking Linseed Oil Cores.*

By A. A. GRUBB and U. S. JAMISON.

The quantity of air which should be supplied to the baking cores is determined by two factors: First, the moisture coming off the cores must be diluted or carried out of the oven, and second, sufficient oxygen must be supplied to oxidise the oil properly. It may be necessary to supply an excess of oxygen over that actually used; if so, how great an excess?

Moisture Elimination.

Green core sand contains on an average about 6 per cent. of moisture. This is nearly all in the vapour form before the bake is half completed. A series of temperature readings made by means of a thermocouple point located in the centre of a baking core show that the rise in temperature is retarded somewhat in the neighbourhood of 100 deg. C., after which it again continues to rise at its former rate, indicating that the water has been vaporised. Each 100 lbs. of green core sand contains about 6 lbs. of water, which upon vaporising expands to about 165 cub. ft. at 100 deg. C., and to still greater volumes at higher temperatures. The steam would thus drive practically all the air from the oven or at least dilute it to an extent that there would be insufficient oxygen for the bake were it not for the admission of fresh air through ventilating ports or openings about the doors. These considerations point to the necessity of introducing some air into the oven in order to carry out the water vapour. Inasmuch as practically all the oxidation occurs during the latter half of the bake, the need for air is not imperative until after all the water has been vaporised and the temperature has risen pretty well toward maximum.

Oxidation of Linseed Oil.

Upon exposure to the air linseed oil absorbs oxygen and is converted into a tough or even hard varnish. Ordinarily this transformation is very slow, but it may be hastened by raising the temperature 300 or 400 deg.; higher temperatures are apt to cause at least partial decomposition.

According to Cloez† fresh linseed oil is composed as follows:—Carbon, 77.57 per cent.; hydrogen, 11.33 per cent.; oxygen, 11.10 per cent.

When thoroughly dried he found that 100 gr. of this oil had increased to 107 gr., as follows:—Carbon, 72.27 gr.; hydrogen, 10.57 gr.; oxygen, 24.16 gr.; total, 107.00 gr.

These figures indicate that in drying 100 gr. of linseed oil, 5.3 gr. of carbon, and 0.76 gr. of hydrogen are given off. Possibly these were given off in part as hydrocarbons, but it is more probable that they were oxidised to carbon dioxide and water. The figures also show that 13.06 gr. of oxygen were absorbed and retained. Assuming that the carbon and hydrogen which were lost were oxidised to carbon dioxide and water, then the 5.3 gr. of carbon would unite with 14.1 gr. of oxygen to form 19.4 gr. of carbon dioxide, and the 0.76 gr. of hydrogen would unite with 6.08 gr. of oxygen to form 6.84 gr. of water. The complete drying of 100 gr. of linseed oil would then require 33.24 gr. of oxygen and would produce 19.4 gr. of carbon dioxide. A. Genthe‡, another investigator, found that in drying, linseed oil absorbed 23 per cent. of oxygen. The work of these investigators, then, indicates that between 30 and 40 gr. of oxygen is required to dry completely 100 gr. of fresh linseed oil.

Laboratory Tests.

A number of experiments were made to determine the quantity of air which should be supplied and the quantity of oxygen actually used in thoroughly baking linseed oil cores. A Vitrosil tube, 1 in. in diameter and 12 in. long with a 4-in. transparent section in the middle, was set up horizontally in such manner that it could be heated with Bunsen burners. In the end of the tube were placed rubber stoppers, one of which supported a thermometer so set that it showed the temperature in the middle of the tube. Air entering the tube was passed through a calcium chloride tube to insure dryness. Upon leaving at the other end of the Vitrosil tube, the gases were drawn through another calcium chloride tube and a soda lime and caustic tube for carbon dioxide absorption. A calibrated water-bottle aspirator was used for drawing air through the train. The air which was received in the water-bottle was analysed for oxygen content by means of an Orsat gas apparatus. The difference between this value and 20.8 was taken as a measure of the oxygen used in baking the core.

The core sand used in the tests was one of the standard mixtures, and it consisted of 70 volumes of Michigan City lake sand, 30 volumes of sand-blast dust, 8 volumes of water, and 2 volumes of raw linseed oil. According to weight such a mixture is 5.05 per cent. water and 1.18 per cent. linseed oil. The sand, water, and oil were measured out accurately and mixed in a glass-stoppered bottle to prevent evaporation. The cores were made and baked in 3-in. nickel combustion boats. The boats were filled with green core sand, firmly pressed down, and then stroked off even with the edges. This produced cores of uniform size. All the test-cores were baked for 45 minutes. When baked they were allowed to cool in a desiccator and were then tested for strength by resting them on two knife edge supports 1¾ in. apart and applying weight midway between the supports. Breaking strengths of less than 450 gr. indicate cores that would be unsatisfactory for general foundry work on account of their fragility, while results over 600 gr. indicate very strong substantial cores.

Additionally, two cores were baked in an atmosphere of carbon dioxide; they were of a greyish colour and so weak that they could scarcely be supported on the fingers. Four cores were also baked in a large excess of air, the ends of the Vitrosil tube being left partly open; the average baking temperature was 200 deg. C., and the average breaking strength was 612 gr.

Laboratory Results Obtained.

While the results were not as uniform as might be desired, they were as nearly so as could be expected from this sort of problem and this method of handling it. A survey of the results shows the following points worthy of notice:—

(1) The nine strongest cores were baked at an average temperature of 200 deg. C. They used 0.73 gr. of oxygen per gr. of linseed oil and broke under an average load of 609 gr.

(2) Three cores were baked at too high temperatures, the average being 255 deg. C. They used 1.36 gr. of oxygen per gr. of oil and broke under a load of 237 gr.

(3) Three others were baked at too low temperatures, the average being 150 deg. C. They used only 0.38 gr. of oxygen per gr. of oil and broke under a load of 319 gr.

(4) Two cores were baked at the proper temperature, but insufficient air and oxygen were supplied; the average baking temperature was 200 deg. C. They used only 0.30 gr. of oxygen per gr. of oil, and broke under a load of 297 gr. Practically all the oxygen admitted to the cores was used.

(5) Considering the nine strongest cores mentioned above, 5,341 c.c. of air supplied the oxygen for baking 76.2 gr. of green core sand; this was in the ratio of 8.5 lbs., or 112 cub. ft., of air at room temperature to each 100 lbs. of core sand. Oxygen to the amount of 475 c.c. was absorbed; this was about 40 per cent. of oxygen content of the air supplied to the cores.

(6) No. 14 used 75 per cent. of the oxygen supplied to it and produced a fairly strong core.

Plant Tests.

An attempt was made to check the above results by tests in an electric core oven in the foundry core room. This oven had a volume of 350 cub. ft. and was equipped with a fan and ventilating device so arranged that the air in the oven could be re-circulated or fresh air could be introduced from without, part of the exhaust passing up the flue. When the fan was operated, it was set to re-circulate entirely or else to re-circulate and introduce fresh air at the rate of about 300 cub. ft. per minute. This figure was determined by placing a Pitot tube draft gauge in the exhaust flue. The temperature of the oven was controlled by a thermostat. Five bakes were made, varying the quantity of air introduced. In addition to the

* Extracted from "Chemical and Metallurgical Engineering."
† Allen's Commercial Organic Analysis, Vol. II. p. 345.
‡ Ibid., Vol. II, p. 348.

XUM

regular cores, twelve test briquettes, similar in shape to those used in cement testing, were placed on each rack. The test-cores were made of the same mixture as the laboratory test. After baking, they were broken on a Wadsworth core-testing machine; a breaking strength of 40 lbs. indicates a fair core, above 60 lbs. a very strong one. Table I. gives a summary of the results obtained :—

TABLE I.—*Tests on Large Core Oven.*

	Wt. of cores.	Tinme in Oven.	Fan recircu-lating.	Fan exhaust-ing.	Air ad-mitted to cores.	Average strength
	lb.	Min.	Min.	Min.	Lb.	Lb.
1	300	68	12	3	85	55
1	387	65	12	1	40	61
3	320	70	15	0	17	54
4	312	78	0	0	17	52
5	337	70	0	1	40	53

In each case, except No. 4, the fan was operated near the middle of the bake. This was done in order to clear the oven of water vapour and other gases. In No. 1 the fan exhausted for one minute about a quarter of an hour before the rack was removed. The figures on "Air Admitted to Cores" were calculated from the period the fan was exhausting and drawing in air, and the estimated air content of the oven was added in; hence these figures are very approximate.

Oxygen determinations were made on samples of air drawn from the oven during the latter part of bakes Nos. 1, 4 and 5. No. 1 gave values of 19.8 per cent. and 18.0 per cent. No. 4 gave 11.3 per cent. and 13.0 per cent. No. 5 gave 16.7 per cent., 14.1 per cent., and 15.0 per cent.

Foundry Results Obtained.

The test-cores differed but little in strength—all were good. Evidently we were unable to cut down the air supply to a point where the strength of the cores was seriously affected. Ventilation served possibly to reduce the time of bake, but even in No. 4, with no fan ventilation, there was sufficient air in the oven or enough leaked in around the doors to produce good cores. According to the laboratory test, 300 lbs. of cores should require about 2.5 lbs. of oxygen. However, 17 lbs. of fresh air contains only 3.9 lbs. of oxygen, so either the "Air Admitted" figures given in the table are too low or the oxygen determinations are too high. It is very likely that more air than that recorded got into the oven, as there were rather loose fitting doors at both front and rear. Even when making allowance for these possible errors, it is evident that from 8 to 10 lbs. of air, possibly less, supplies sufficient oxygen to bake properly 100 lbs. of green core sand.

Conclusions.

In order to bake linseed oil-bound cores properly, at least 1 lb. of oxygen should be supplied for each pound of linseed oil in the cores. This would require about 4.5 lbs., or 60 cub. ft., of fresh air. Each 100 lbs. of green cores should then have at least 5 lbs., or 67 cub. ft., of air. These figures indicate only the minimum quantity required for oxidation purposes. It is well to change the air in an oven at least once after the moisture has been vaporised. Where fuel is cheap, greater excesses of air probably have no harmful effect and may be of advantage.

In the correct bake linseed oil uses about 0.73 per cent. of its weight of oxygen. This figure is considerably higher than those given by Cloez and Genthe, referred to above, for oxygen used in drying linseed oil. We need not be surprised at this, because a properly baked core is more than dried. We have found in our core room that a linseed oil core shows a slight greenish tinge when merely dried out. When a brass casting is poured about such a core, a "core blow" is very apt to result, and the core, instead of becoming very fragile and easy to remove, bakes hard in the casting. On the other hand, when baked to a decided brownish colour, they can usually be knocked out of the castings without trouble.

These facts indicate that in core baking the oxidation process is carried beyond the drying stage; the oil is actually burned in a slight degree.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Making Moulding Boxes,

SIR,—I have read with much interest the articles by Joseph Horner on the above subject, but would like to point out some things I have found useful when making box-parts.

Small boxes 14 in. and less are best *without* handles, but with two lugs cast on each side or end, the lugs being clear of the box edges and drilled to take loose pins. These boxes are very useful when having to make castings with two, three or more joints, as they can be built up to any required height.

Larger size hand boxes made to take loose pins are used for machine moulding, as one pair of pins can be used for any number of boxes, the pins being put in the top and withdrawn when it is put on.

All pin holes should be drilled to a template so that all parts of any given size are interchangeable, as much time is often wasted in the pairing of boxes.

In making large size boxes the lugs, flanges and loop handles are often put in by the use of a strickle. A strickle is cut to the required depth, the top of the box frame being used as a guide; a level bed can then be made, a loose lug is put to a centre marked down the box pattern, rammed level, jointed, drawn and covered with a sand or loam cake. The same method is used for both internal and external flanges.

When making boxes requiring loop handles a thickness piece is often used of larger width than the handles and same depth as the box. A strickle is made to the required depth, and a hole is strickled out larger than the width of the handles. The handles are put in after the pattern is drawn and the side made up level to the joint. This method might put more work on the moulder, but against this, there is the saving of the core box and core-making.

Swivels are often made of cast iron of larger section than wrought iron, in which case a core is needed; but it is not necessary to make a core box. A round bush or cup can be used in which to ram up the swivel pattern. A piece of core will cover the collar end and a round piece of wrought iron may sometimes be cast in the centre of the swivel. A hole can be made through the core, which covers the end of the swivel, and the wrought-iron bar is pushed into position after the pattern is drawn. The moulder must use care to ensure the swivel is central.

In making large boxes it is advisable to make top parts first. If loose bars are placed towards the centre of the frame the outside can be rammed nearly level without much fear of the sides ramming in, and a good rapping round the inside at this point will make it much easier to draw the pattern from the sand. The bars can be used similarly when making the middles and bottom.

The frame can be put on loose sand at each corner and levelled; weights should be placed on to prevent the frame from "ramming up." It is an advantage to put new sand under the frame, as any sand falling after the pattern is drawn is more easily seen.—Yours, etc.,

F. M. SHIELD.

Newbury,

Sulphur in Foundry Coke.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I wish to call attention to the remarks made on the sulphur content of coke made during the discussion of the Paper on "Hard Castings," given before the Lancashire Branch. In this Paper it mentions 0.20 per cent. of sulphur as being 2½ times the usual amount. The minimum-maximum percentages used to be .50-.75 per cent. of sulphur, and I only wish I could hear of cupola coke containing such a low sulphur content as 0.20 per cent. I must apologise for troubling you in this matter, but the statement made would be very misleading to anyone not conversant with the analysis of cupola coke.—Yours, etc.,

J. H. C.

Foundry Re-organisation.—Part VII.

By H. W. J.

In the re-organisation of the foundry there are a great many factors which, although apparently trivial, yet have an important effect upon the vital matter of cost. Many of these small points have been commented upon in this series of articles, and there are others which will occur to the foundryman during the process of re-organisation.

It must be borne in mind that "costing" is done in the workshop and not in the costing department. This department exists for the purpose of recording costs in a scientific manner, but it must have data upon which to work. The most elaborate cost office in the world can only work upon "information received," whether this be available automatically or sought after. It should be the aim of the foundry manager to ensure that the "automatic process" is developed, and can be relied upon, for "sought after" information entails wasted time, which is really a superfluous cost.

The cost office itself must be efficient but need not be elaborate. The cost clerk must know his work so that, should any discrepancy occur, it can be immediately detected, and this is why a real cost clerk, and not an adaption, must be in charge. In spite of every precaution there is always the possibility of error, but because this is occasioned at an early stage that is no reason why it should remain undetected at the final stage.

twenty are not produced as cheaply as the one, for, apart from the extra cost of metal, there are the numerous "aids" to be paid for, but it is a paying proposition nevertheless.

We have the same floor space as before, and we still pay the same amount of rent, but we are getting twenty times the output. Our wages bill is up, and heavy sums are paid away in improvements to plant, but the more spent scientifically in this direction the more output is increased. Whilst the spending figures are 10 + 5 + 2 + 1, the output values are 20 + 15 + 10 + 5, so when once we start there is every incentive for us to continue.

And when we can produce economically we can produce quickly, which means that we must extend our business connections. It is of little use handling the job smartly if by so doing we are able to run the foundry but three days a week. If we can handle 100 tons a week, then we must get orders for that amount, otherwise we are making a profit on the first half of the week and losing it on the latter half.

We must therefore attract new business, and to do this we must be prepared to quote a competitive figure. This is the sphere of the cost office, for the costing records form the basis for our estimate, and, as before mentioned, those records must be reliable. It is not enough for the shop foreman to boast that they are producing economically—the

A *Althere & Co.* COST CARD. Pattern 189 B.

Shops Order.	Date.	Quantity.	Wages (per 10)	Overhead.	Material Weight (per 10)	Material Cost. (per 10)	Freight.	Total Cost (per 10)	Finished Weight (per 10)	Cost per cwt.	Selling Price per cwt.
			Pence.	Pence.	Lbs.	Pence.	Pence.	Pence.	Lbs.		
1472	*8/8/21*	*2,000*	*8.2*	*15.3*	*30.24*	*32.4*	*6.07*	*61.97*	*22.5*	*25/8*	*30/–*

FORM 1.—SHOWING THE METHOD OF DETERMINING THE SELLING PRICE OF CASTINGS.

The real point, however, is to have a shop system which will give the cost clerk every facility, so that his whole service is productive. The system must be such as will warrant confidence in the records compiled, for without this confidence records are but a mass of meaningless figures. If the cost of a certain job is asked for, that does not mean an approximation, for the manager himself would be able to give this without the expense of a cost office.

Efficient costing is made possible by concentration upon economical production and progressive output, and this is why the "clearing up" processes described in the preceding articles must be persevered with. The output per man must be the highest possible, but unaided human effort is but limited, and the limit is reached long before there is a margin of profit under the present competitive system. So in the first place it becomes necessary to extend the limit by means of assistance, and this assistance falls within two categories.

The first takes the form of the demolition of impediment, so that the operator may work unobstructed and to the limit of his capacity. The measures employed aim at the removal of anything savouring of time wasting, and so matters likely to have an ill-effect upon his health are dealt with. Then the shop system is devised to eliminate the superfluous—the shop is planned to reduce walking time, the store to ensure prompt supplies, and shop orders to obviate waiting time whilst seeking fresh instructions. Within the second category appear the mechanical aids, which aim at extending the natural human limit—the moulding machines, mechanical transport appliances, and the like.

This enables us to produce economically by ensuring the major portion of everyone's time being directly productive. It is not a question of growing three blades of grass where two had grown previously, but of producing twenty castings where one had previously been produced. True, the cost clerk must know it, and so the shop system must be devised to allow for all information to be at the disposal of the cost clerk.

The cost of a mechanical contrivance, such as a moulding machine, must be charged against the floor area upon which it stands, otherwise the net productive value of that area will not be known. And assuming that the installation of machines means a big increase in output, much of the increased value is lost if the transport facilities are not adequate. As far as possible expenses should be correctly apportioned, in order for the real value of any improvement to be ascertained, but in many costing schemes there are far too many expenses charged against the foundry as a whole without any attempt at apportionment, and the real significance is as a consequence somewhat obscured.

Rent, rates, taxes, and the like are charged against the foundry as a whole, though even here sectional apportionment can be effected, and the same remark applies to administrative and management expenses. If one section is primarily engaged upon intricate work, not only is there a higher labour cost but there is a higher management cost as well. On the other hand, a section may be devoted to simple mechanical moulding, and the labour cost is proportionately low, but here again management costs are heavy on account of the closer supervision of semi-skilled labour.

Administrative expenses must be closely watched, though this does not mean that they must be reduced without consideration. Very often it will be found that high administrative charges are not only justified but they are a real asset on account of the saving they effect in other directions. What must be ascertained is to what extent administration is productive, and to ensure that any increase in the charges is followed by an improvement in production.

This is the information that the cost clerk must procure to facilitate the explanation of why

castings can now be delivered at 30s. per cwt. whereas a year ago they could not be delivered under 50s. On the one hand the difference in material costs is quite obvious so long as these are properly recorded and wage reductions are clearly shown. But apart from these there is the record which shows the part the foundry itself is playing in the cheapening of production.

That is the most important factor and merits the closest consideration. Let us assume that we know the charges for rent, rates, taxes, lighting, administration, etc., a fixed sum being set apart to cover these. The material costs must then be ascertained. We know the amount of material necessary for charging the cupola and can therefore calculate the cost, whilst from past experience the melting losses are established. If the cost of the material is decreased, and there is a reduction in the operator's wages without a corresponding reduction in output, it is quite easy to show a drop in the price of the finished castings. But more than that is necessary for all our competitors can do likewise, and so we are not securing any advantage. It is when the foundry itself participates that the proposition becomes interesting and profitable.

Castings are being produced at 30s. per cwt., but to produce them at 20s. is necessary in order to meet both home and foreign competition. We are out not merely for *orders* but for *business*, which means the execution of orders at a profit. And one shop system and costing record must supply the information.

We have shown how foundry orders are issued for the goods required, and it must be remembered that the office is the customer's representative, so that to all intents and purposes the office is a customer of the shop. All expenses incurred in connection with one specific foundry order are charged against the number reserved, so that the recording of costs is simplified.

Whilst no particular costing system is advocated on account of the different methods of production favoured by the various foundries, we may, for the purposes of illustration, assume that a cost card is in evidence for each different pattern number whilst a detail cost sheet or card is used in connection with each shop's order. As not more than one pattern number appears on each shop's order, obviously whilst the detail cost sheet gives full particulars of all costs incurred in connection with a specific shop's order, the cost card is a condensed record of a permanent character, and can be used for comparison purposes.

This will show the cost of the same casting at different periods, for it is assumed that we are particularly concerned with repeat orders. These cards may, for convenience, be filed under the customer's name, for it is unlikely that the precise method of numbering patterns is resorted to by more than one firm. Whilst work is in progress the detail cost sheet is used, but when the job is completed all costs are summarised and recorded upon the cost card.

The Determination of Tin in Brass.

One hundred and thirty grams. of brass are dissolved in 900 c.c.s. HNO_3 (s.g. 1.2). The solution is boiled down to a thin syrup, then diluted with hot water to about 900 c.c.s. If the precipitate of tin is appreciable it is estimated as follows:—Two grams of metal are dissolved in 10 c.c.s. HNO_3 (s.g. 1.42, 10 c.c.s. H_2SO_4 (s.g. 1.84), and 30 c.c.s. of water. The solution is boiled to expel all nitrous fumes and then cooled; 50 c.c.s. of cold water are added, and the copper is removed by electrolysis. If any $PbSO_4$ is present, it is filtered off through a double S.C. and S. 590 filter paper and to the filtrate 100 c.c.s. of 2 per cent. H_2SO_4 saturated with H_2S are added, and a strong current of H_2S. is passed through the solution for half an hour. The solution is then just boiled, the precipitate filtered off, washed well with hot water, dried and ignited and weighed as tin sulphide.

Factor to tin = 0.788. F. A. L.

MR. J. BALLANTYNE, chief goods manager of the Caledonian Railway, and Mr. R. Killin, superintendent of the line, have respectively been elected chairmen for the ensuing year of the goods managers' and superintendents' conferences held periodically at the Railway Clearing House.

Pennsylvanian Foundry Extensions.

According to the "Iron Trade Review" extensive improvements recently have been completed by the Birdsborough Steel Foundry and Machine Company, Birdsborough, Pa., U.S.A. Both the steel foundry and iron foundry have been extended and these departments now connect with each other. The steel foundry extensions are 241 ft. × 240 ft. and 121 ft. × 110 ft. respectively. The 241 ft. × 240 ft. extension is in the form of five bays which extend east and west. Two of these are 60 ft., and one is 50 ft., one 40 ft. and one 31 ft. wide. The 121 ft. × 110 ft. extension is in three bays; one 31 ft., one 40 ft., and one 50 ft. The original steel foundry was 240 ft. × 220 ft. The entire steel foundry now is 430 ft. long, with varying widths as denoted above. In effect, the original building is an extension of the 50-ft. and one of the 60-ft. bays in the 241 ft. × 240 ft. structure. The 40-ft. and 31-ft. bays and one of the 60-ft. bays are devoted to moulding. One 60-ft. bay and the 50-ft. bay are reserved for pouring and cleaning. The iron foundry has been extended 120 ft., and now connects with the steel foundry. The present iron foundry now is 340 ft. × 60 ft., and on its east side has a 120 ft. × 24 ft. lean-to.

To handle the materials for the cupola in the iron foundry, a runway has been erected over the stockyard in the rear of the iron foundry. This is 233 ft. long and has a 40-ft. span. It is equipped with a 5-ton mono-rail crane which transports materials to the cupola-charging floor by means of buckets and magnets. On the charging floor the pig-iron and coke are dropped into pans at the cupola doors and the material is pushed into the cupola by a pneumatic ram. A new 35-ton crane with 60-ft. span has been installed in the iron foundry, giving this department a total of three cranes. A new cupola, 84-in. in diameter inside the shell, has been added, making a full complement of two 84-in. and one 60-in. cupolas. Their total melting capacity is 35 tons per hour. Two new drying ovens have been installed, making a total of five. Two pneumatic jar-ram moulding machines have been installed, and the iron foundry has been provided with a pit for pouring rams for accumulation and vulcanising presses and for pouring ingot moulds. The iron foundry is devoted to the production of all kinds of large engine and turbine castings, castings for hydraulic and rolling mill machinery, ingot moulds, and chilled-iron pump-plungers. The foundry is equipped with a 25-ton air furnace for providing metal for castings requiring hydrostatic tests.

Two new cranes of 20 and 50 tons capacity respectively have been installed in the steel foundry, and the capacity of two existing cranes has been increased from 25 to 40 tons each, giving this department a total crane equipment of four 5-ton, one 25-ton, one 30-ton, one 50-ton, two 40-ton, one 35-ton, one 20-ton, and one 10-ton crane. A new 30-ton basic open-hearth furnace has been installed, making a total of three open-hearth furnaces, the two others being acid furnaces of 25 and 37 tons capacity respectively. A 10 ft. × 60 ft. oil-burning furnace of the car type has been built especially for annealing locomotive frames and long hydraulic cylinders. A 10 ft. × 15 ft. car type oil-burning furnace also has been installed for annealing miscellaneous castings. Two new tumbling barrels have capacity for cleaning castings weighing up to 700 lbs. each. For moulding miscellaneous locomotive castings, two pneumatic bumper and roll-over moulding machines, 40 ft. × 60 ft. and 42 ft. × 60 ft. respectively, recently have been added.

A 187 ft. × 60 ft. structure has been added to the machine shop. The two original machine shop buildings were 180 ft. × 78 ft. and 120 ft. × 60 ft. respectively. The equipment includes two 6-ft. drill presses, a 101-in. vertical boring mill, a 60-in. vertical boring mill, 40-ft. heavy duty engine lathe, a 10 ft. × 15 ft. planer with 25-ft. stroke, a 42-in. roll lathe, and a travelling head planer with 72-in. horizontal and vertical travels. A new 50-ton crane has been installed, giving the machine shop a total of three cranes, with capacities of 20, 35, and 50 tons respectively. With the equipment which has been added it is possible to machine and handle castings weighing up to 65 tons each.

Moulding an Odd-shaped Pipe.

By E. Longden.

A pipe of the nature outlined in Fig. 1 was urgently required, and as there was no likelihood of a second casting being ordered, it was very desirable that the pattern be constructed as cheaply as possible. Consequently, only a skeleton pattern was made, as shown at Fig. 2. It was made very quickly, and the saving effected in patternmaking costs far outweighed the extra time to mould the casting in the foundry by an uncommon method.

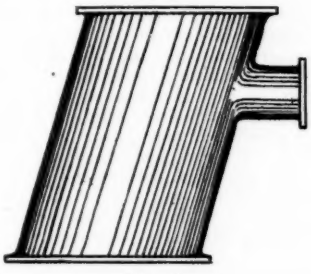

Fig. 1.

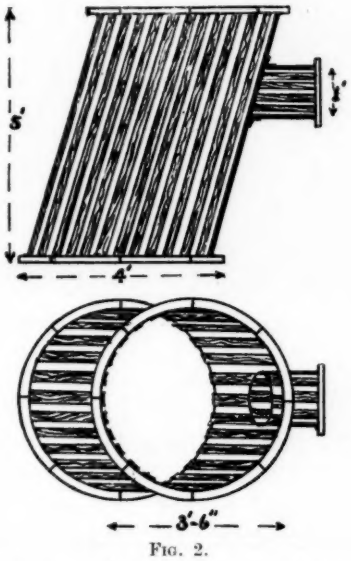

Fig. 2.

Slightly less than a half-sectional view of the completed mould is shown at A, Fig. 3, and at B, B the plan of two drawback plates placed in position against the pattern. C and D are wrought iron bars cast in the plates to steady and support the sand.

To mould, a hole is dug in the floor about 6 ft. in depth. A strong core grid, shown at E, Fig. 3, is bedded down, 1 ft. below the bottom flange of the casting to act as an anchor to the overhanging body of sand and material forming the body and

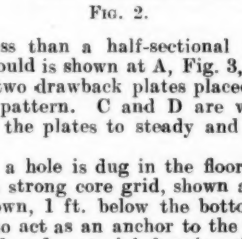

Fig. 4.

branch core. Hook bolts, F, and brick bearers, G, are set, and a level bed made to receive the bottom side of the pattern. Before proceeding to build the core, the pattern is supported by a strut placed under the branch. The core is rammed and reinforced at intervals by pieces of wrought or cast iron and grids. To support and bind the branch to the body a grid is made as shown in Fig. 4. The grids are supported and bound together as illustrated in Fig. 3. A cinder vent is built in the centre of the material, met by holes made by the vent wire.

One of the drawback plates is next placed on the prepared bottom joint and boards set in position to form the vertical joints at H, H, Fig. 3. When the ramming has reached the point I the bars C and D are bound together. The remainder of the drawback is rammed to the top joint, strengthened at intervals by long pieces of wrought iron, which extend nearly the whole width of the drawback. Brown paper is tacked on to the vertical joint, and the second drawback rammed in a similar manner. Snugs J are used for locating the stakes. The top part is rammed, lifted off, a hole dug round the drawbacks, and the mould split at the joint H, H. After dressing, the drawbacks are placed in the stove to dry.

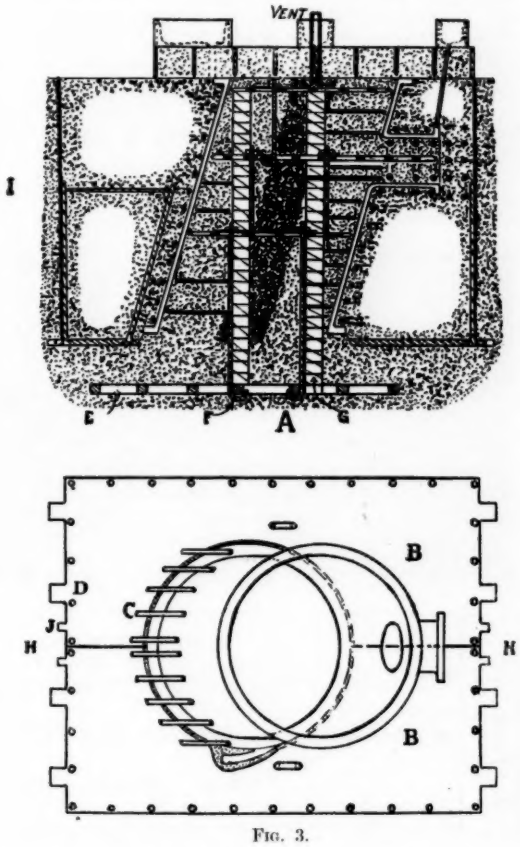

Fig. 3.

To take the pattern from around the core it is necessary to saw the pattern in half along the line which corresponds to the drawback joints. The core is dressed and dried in position.

It takes very little time to close and prepare the mould for pouring, which is filled by way of the bottom flange.

X Rays in the Iron and Steel Industry.—Major G. W. C. Kaye, in the course of his third Cantor lecture, remarked that electric and oxy-acetylene welding have come into great prominence during and since the war; an indifferent welder can turn out what appears, on the surface, to be an excellent weld, but is quite an unreliable job notwithstanding. There appears to be no adequate mechanical test for a weld, and in any event any such test, whether mechanical or microscopical, destroys the weld. The X-rays promise to be of great use in this connection. If the component parts are not actually fused together, a narrow dividing line comes out on the plate. Blisters and blowholes show up as light spots. The X-ray method has proved to be a somewhat severe critic of present-day welds as commonly carried out. Hidden cracks in a metal can often be detected, though if they are very fine or tortuous (hair cracks) the method is rarely suitable. Such cracks are sometimes the sequel to pipes or blowholes in the ingot, and it is easier to detect them in the ingot than after working. In the case of alloys, the uneven distribution of any component results in a patchy or streaky radiograph. The X-ray method has also found application in detecting hidden corrosion (as in gas cylinders, in ferro-concrete and cables), in scrutinising steel turbine discs for segregations, etc.

C

The Metallurgy of Annealing of American Malleable Cast Iron.*

By H. A. Schwartz.

It has been repeatedly stated that annealing consists primarily of the conversion of the metastable system Fe-Fe_3C into the stable system Fe-C. This involves no change of chemical composition, and is not the effect of any chemical action on the iron by packing, furnace gas, or other substances. The only chemical reaction involved takes place within the iron carbide or cementite of the iron, and involves only the chemical elements present within the iron, in unaltered amount before and after the reaction:—

$$Fe_3C=3Fe+C.$$

The reaction involves the absorption of heat (8,940 small calories per gramme molecule), and hence the reaction will continue only if heat be supplied.

The two illustrations (Fig. 1) show the rim of a casting containing most of the usual defects due to annealing.

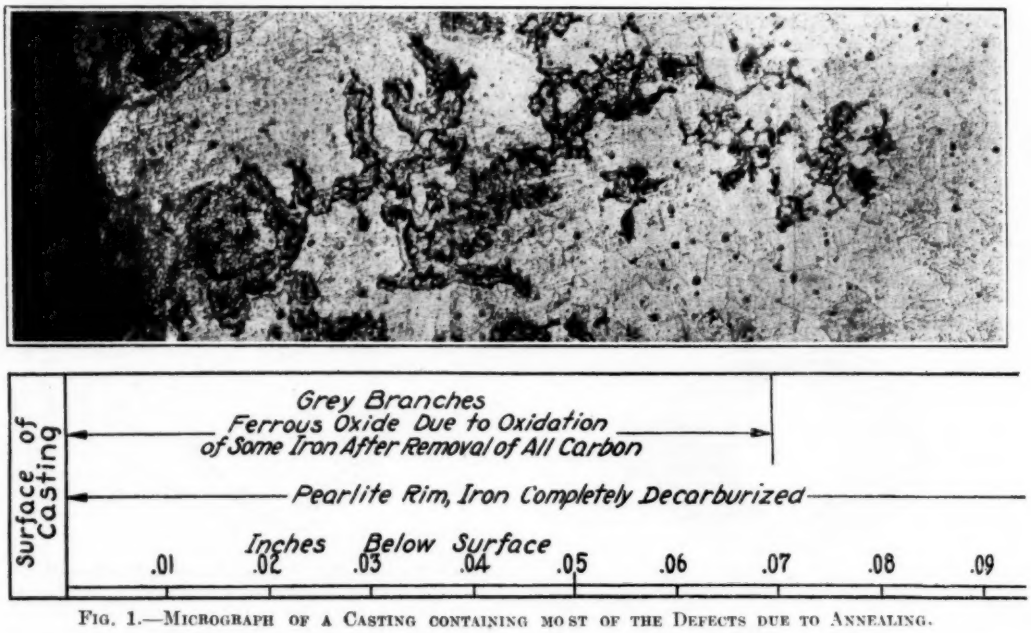

FIG. 1.—MICROGRAPH OF A CASTING CONTAINING MOST OF THE DEFECTS DUE TO ANNEALING.

It has previously been pointed out that the reaction is necessarily incomplete at all temperatures above the lower critical Ar_1 of the final alloy. The data in the writer's possession have given him cause in the past to feel that the action approaches completion at a uniform rate as the temperatures approach Ar_1. This assumption is in line with the equilibrium diagram given for the stable system, in which the solubility of carbon (not cementite) is *nil* at Ar_1. R. S. Archer, in a Paper presented at the February, 1920, meeting of the American Institute of Mining and Metallurgical Engineers expresses his conviction that the solubility does not approach *nil* at Ar_1, but that there is a eutectoid ratio with a carbon concentration of roughly 0.6 per cent., below which the combined content cannot be reduced till Ar_1 is passed. The point is of considerable scientific interest and deserves further study, but need not alter our general conclusions in the present connection.

Metallurgically, the purpose of the annealing heat-treatment is to cause the iron to traverse such a temperature cycle as will completely and most expeditiously transform it into ferrite and temper carbon, having due regard also to the resultant grain structure of the ferrite. The actual heat cycle required to accomplish this result depends upon the chemical composition and previous thermal history of the product annealed.

The control of the annealing oven to produce a given cycle is further influenced by the design of the furnace, the uniformity of temperature throughout, rate of heating, etc. Therefore the art of annealing cannot be adequately taught in a chapter of a book. At most the general principles may be outlined, it being understood that in practice the operations are shaped toward the desired end in accordance with the skill and experience of the annealer.

It has been already shown that the graphitisation of cementite occurs more rapidly the higher the temperature, and that the rate of this reaction decreases as the reaction approaches its end point. Consequently, at first glance it would seem advantageous to conduct the process in the beginning at the highest possible temperature. However, there are practical and theoretical objections to this procedure. The practical objections in order of importance are as follows:—

1. The extreme warping or distortion of castings when softened by the high temperature.
2. The sintering or fusion of any available packing material from the same cause.
3. The wear and tear on the firebrick of the oven.
4. The decreased service obtained from annealing pots.
5. The increased fuel cost of attaining extremely high temperatures.

The theoretical reasons are even more important, being:—

1. The large flaky character of the free carbon crystallising out at the higher temperatures.
2. The poor ferrite structure set up under these circumstances.

Accordingly the metallurgist must determine for himself where the best balance between speed and quality may lie, having regard to the alloys with which he has to work. Opinions vary somewhat, but the advantageous maximum of temperature of castings, as distinguished from furnace atmosphere or wall temperature, lies between 865 and 925 deg. Cent. While graphitisation can be initiated at temperatures far below 815 deg., the reaction at these lower temperatures is prohibitively slow, without any compensating advantages. Few packings can be found which will withstand temperatures in excess of those occurring when heating castings to above 925 deg. Cent. Moreover, the effect on grain structure begins to make itself felt at this temperature.

The reaction at 980 or 1,035 deg. Cent. is not sufficiently faster to warrant incurring the increasing difficulties which present themselves above

* Extracted from the "Iron Trade Review."

925 deg. Many malleable operators feel that the extra time required to anneal at temperatures not exceeding 870 deg. is well spent.

A safe maximum temperature having been determined for the particular product under consideration, the annealer first directs his attention to attaining this temperature as rapidly as possible consistent with a reasonable uniformity of temperature throughout the oven. It is here that oven design influences the economy and quality of the annealing operations.

It is unavoidable that those pots nearest the source of heat will heat more rapidly than the rest. However, if a furnace is designed to permit the rapid and free circulation of flame, the differences of temperature will be far less than where such circulation is hindered to some extent.

All commercial furnaces have the heat supplied above the pots, and all well-designed furnaces have a sufficient height of roof to permit the flame to reach freely to the tops of the farthest pots. The author has never heard any annealer question the reason for introducing the heat at the top, all seeming to take this arrangement for granted. However, there is a good scientific reason for this design. The heating of the furnace contents is accomplished mainly by the vertical gas currents

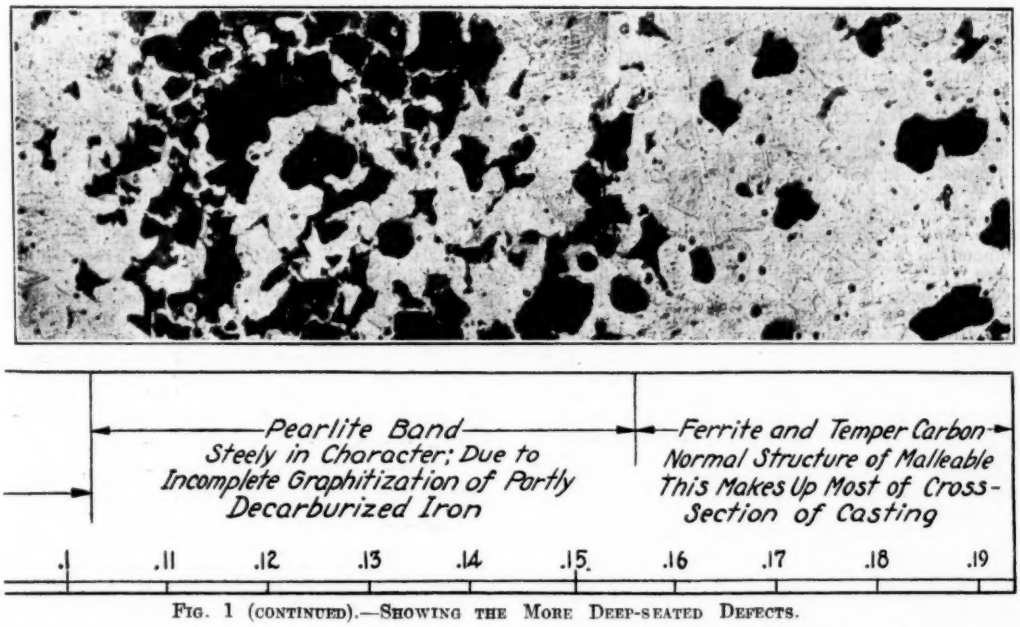

FIG. 1 (CONTINUED).—SHOWING THE MORE DEEP-SEATED DEFECTS.

in the spaces between the several stacks of pots and, to a minor extent, by conduction downward through the pot and contents. If two of the vertical passages between the pots are at different temperatures, a gas current will be set up, rising in the hotter and descending in the colder of the two. Therefore, if the hot gas enters at the top, this circulation will tend to divert the descending hot gas from the hotter passages toward the colder spaces and thus heat the latter more rapidly. Were the heat admitted at the bottom the circulation described would cause an increase in the difference of temperature between the hot and cold passages, since the ascending current in the hotter space would draw the hot incoming gases with it.

Time of Heating.

The rapidity with which an oven can be heated uniformly depends entirely upon its construction. A number of observers have recorded heating cycles with pulverised fuel as short as 18 hours, whereas the author frequently has witnessed periods as long as 100 hours and over, usually under adverse fuel conditions. In some cases the increased time is due to the impossibility of burning the coal rapidly, whilst in others the rate of downward distribution of the heat in the furnace is the limiting factor. In the latter case it sometimes is necessary almost to cease firing and allow the heat to equalise by conduction and radiation in order to avoid overheating the top pots. This procedure is sound metallurgically, but necessarily involves a waste of time.

The desired maximum temperature having been reached as uniformly and rapidly as possible, the next step is to maintain this temperature until the reactions within the casting have attained a state of equilibrium. The time depends on the temperature chosen. At 1,035 deg. Cent. it is from 10 to 15 hours, depending on the composition of the iron involved. At 925 it is from 20 to 30 hours under ordinary conditions; at 815 deg. the time increases to between 50 and 70 hours; and at 760 deg. the time would be extremely long—certainly over 100 hours.

The time required is approximate inversely proportional to the temperature above A_1 for alloys high in carbon or silicon the time required is less than for those lower in these elements. The presence of excessive manganese or sulphur, or of some of the more unusual elements, may prolong the time considerably. Also it is believed that the rate of freezing and possible other variables in the previous thermal history of the metal have an effect upon the rate of graphitisation.

The combined carbon content at equilibrium is greater the higher the temperature, therefore the iron is not completely annealed at the expiration of the required time at the maximum temperature chosen. The carbon content, or solubility of carbon, as dependent on temperature, has not yet been definitely determined. In the writer's opinion, the solubility is 0 at about A_1 and about 1.7 per cent. at 1,370 deg. Cent., and is nearly a straight-line function of the temperature between these points. Archer believes that the solubility is somewhat less than 0.85 per cent., apparently about 0.65 deg. at A_1. No matter which assumption is correct, the carbon will not be insoluble in iron, and therefore the anneal will not be complete unless the reaction is allowed to progress to equilibrium at or just under Ar_1. The Ar_1 point in commercial iron probably is between 725 and 745 deg. Cent., although the author has found it as low as 695 deg. Cent. in at least one case.

One way to accomplish the desired result would be to drop the temperature quickly from the maximum to just under Ar_1 when the reaction at the former temperature is complete, and to maintain that temperature below Ar_1 as long as may be required to re-establish equilibrium at the lower temperature. This operation will readily yield perfectly annealed material, but is difficult to execute in practice, except possibly in tunnel furnaces. It also is wasteful of time, since equilibrium can be attained more rapidly just under Ar_1, by approaching this slowly from above at a rate permitting the graphitisation to just keep pace with the falling temperature than by a quick drop and a long wait to establish equilibrium. Rates of cooling between 4 and 10 deg. per hour usually are desired, and most operators prefer to cool more and more slowly as the temperature drops.

To make sure of attaining equilibrium a number of annealers wisely attempt to hold a constant

temperature just under Ar_1 for some time. Nothing is gained by additional slow cooling after the reaction at Ar_1 is complete.

In many plants the cooling rate is determined by the heat radiation of the furnace. In these cases the annealer merely seals the furnace at the high temperature and lets it take care of itself. Fortunately, since the rate of cooling decreases as the temperature of the oven falls, a well insulated furnace cooling naturally will fall in temperature at a steadily decreasing rate, as the metallurgical theory requires. Therefore the results of this practice often are much better than might be expected. Difficulties begin to arise when the cooling is accelerated by some unforeseen or unknown cause, and the illogical operator is no longer able to account for his results.

It will be noticed that a complete annealing cycle may be subdivided into five distinct intervals as follows:—Heating to maximum temperature, maintaining maximum temperature till equilibrium is attained in graphitisation of cementite cooling to critical point, holding at critical point, and further cooling to permit handling.

The first and last periods have no metallurgical significance, and can be accelerated as much as is convenient. However, the second and the combination of the third and fourth, are determined by the product being manufactured, and cannot be reduced below definite minimum values. The minimum cycle is divided as follows:—Heating to 870 deg., 30 hours; holding at 870 deg., 45 hours; cooling to Ar_1 and holding there, 35 hours; and cooling to handle, 5 hours. The total is 115 hours, which would make a six-day annealing cycle as an absolute minimum, the time above 115 hours being spent in charging and pulling. However, few plants are able to insure success in so short a cycle, and seven days may be considered as the commercial minimum. Cycles of nine days and more are not uncommon with large furnaces in order to secure the best results.

The minimum annealing time is fixed by natural laws, which cannot be changed to suit the wishes of the manufacturer or the consumer. Any attempt on the part of the user to hurry the producer is misguided. The response to such pressure will be in inverse ratio to the conscientiousness and intelligence of the particular manufacturer concerned. It would seem that self-interest will drive the malleable founder to adopt the quickest workable cycle to avoid the investment in additional ovens and their fuel supply. Nevertheless, the author has known many purchasers of malleable who seemed to regard the operation of a long cycle as an arbitrary wish of the manufacturer imposed upon his customer without any adequate reason.

For many years the larger producing interests have been approached from time to time by frequently sincere but always poorly-informed inventors claiming either to much reduce annealing time or sometimes to do away with annealing entirely. As a rule, those in the former class expect to accomplish results by changes either in furnace design, methods of heating, etc., or by some unusual and often secret packing. Being an atomic rearrangement within the metal itself, the annealing reaction cannot be accelerated or retarded by the material surrounding the casting.

The laws governing graphitisation have been investigated by a number of entirely competent experimenters, and depend on clearly-known chemical fundamentals. The design of heat treating furnaces also is well understood. Changes in furnace design could only reduce the annealing time by accelerating the time of heating, since, as already explained, the times and temperatures during the rest of the cycle are fixed by the metal being annealed. All of these patented or secret annealing methods, therefore, are foredoomed to failure.

It is conceivable, although improbable, that someone will discover an alloy with a carbon content, similar to that now used, of such a character that graphitisation will be suppressed at temperatures above 870 deg. Cent., but which will graphitise easily or even spontaneously at lower temperatures. Such an invention would accelerate or eliminate the present annealing process. Since the alloys of iron with most of the reasonably common elements are constantly being investigated, and no indications have been found of any elements with properties producing the complex effect here described in any degree, it seems most unlikely that any accelerated annealing method for producing black-heart malleable will be found.

Therefore, producers and consumers admit the necessity of adequate time for annealing, and conduct their several operations in accordance. The author is still waiting to hear from a most enthusiastic engineer who, three months before this was written, offered to demonstrate the manufacturer's ignorance of annealing principles by taking home a sample of hard iron in the evening, annealing it over night, and returning it completely annealed the next day.

Other incidental changes are produced on the metal while graphitisation is going on. The clearest evidence that these changes are only incidental is the fact that the process of graphitisation can be carried on perfectly without any gain or loss of weight. To prove this, an accurately weighed specimen of hard iron can be enclosed in a tube of fusible glass, the air displaced by hydrogen, and the hydrogen pumped out to a fairly low pressure and the tube then sealed, so that the metal can be annealed surrounded by nothing but a trace of a reducing gas. Samples of 10 or 12 grs. weight annealed in such a tube in accordance with the heat cycle of commercial practice are unaltered in weight to 1-10 milligramme. In other words, the weight remains constant to 1-1,000 of 1 per cent.

Migration of Carbon.

However, under commercial conditions the castings always are in an atmosphere having oxidising possibilities. This atmosphere may be the atmospheric air remaining in the spaces not otherwise occupied, or it may be the product of combustion or gases arising from reactions with packing materials. Therefore there always is a tendency toward burning out the surface carbon. The mechanism of the removal is interesting. Only the carbon in the outer layer of molecules can combine directly with any oxygen in the surrounding gas. Therefore, unless either the gas can penetrate the solid metal or the carbon can migrate to the surface, decarburisation would be limited to the infinitesimally small amount produced by burning out the carbon one molecule deep.

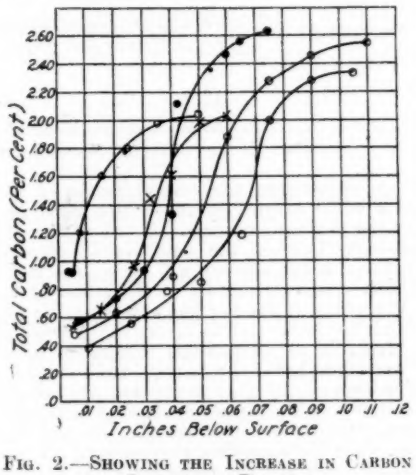

FIG. 2.—SHOWING THE INCREASE IN CARBON AT INCREASING DEPTHS.

At one time it was generally believed that the gas penetrates, but the migratory action certainly exists, and is probably the major method by which carbon and oxygen are brought together. Carbon exists in iron at any temperature above Ac_1 in part, as a solid solution of a definite saturation value at any given temperature. If the carbon concentration is locally lowered below saturation, diffusion will enrich this area at the expense of the more highly carburised areas. So long as cementite, or undissolved iron carbide remains, the deficit will be made up by solution of additional amounts of this element in such a quantity as to maintain the solid solution in a saturated state.

This migration requires considerable time, so that in general, carbon is oxidised at the surface much more rapidly than diffusion can equalise the

carbon content. The result is a material poorer in carbon at the surface than in the centre. As we go further below the centre the increase in carbon content corresponds to a sort of gradient which is sufficient to feed the carbon to the surface as fast as it is removed.

Fig. 2 shows the increase in carbon at increasing depths below the surface. The graphs represent various degrees of decarburisation under commercial operating conditions. It will be noted that the graphs vary both as to carbon concentration at the surface and as to the depth of penetration.

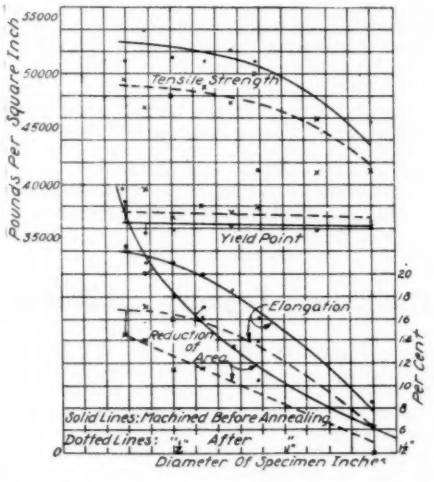

FIG. 3.—SHOWING THE EFFECT OF REMOVING 1-16 IN. DECARBURISED SURFACE IN SPECIMENS OF VARIOUS DIAMETERS ON THE TENSILE PROPERTIES.

The former depends somewhat on the oxidising medium employed, the latter on the length of time, the medium applied, and on its activity.

Results of Tests.

The effect of this decarburisation on the physical properties of the product are relatively small. Fig. 3 shows graphically the results of careful tests made to determine the effect of the removal of 1-16 in. of carburised surface in specimens of various diameters on the tensile properties of the metal. The experiments were conducted by casting tensile specimens of a series of diameters, grinding one specimen of each size truly cylindrical, removing about 1-16 in. of stock. The ground specimens then were annealed with rough specimens from the same heat and turned to size after

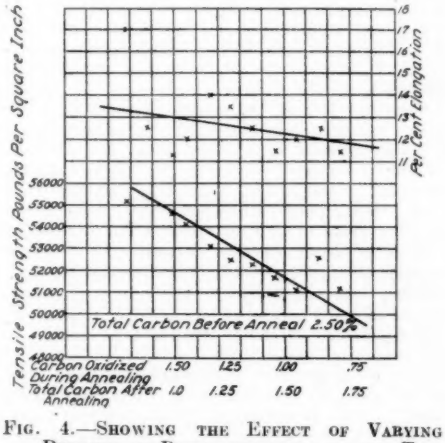

FIG. 4.—SHOWING THE EFFECT OF VARYING DEGREES OF DECARBURISATION ON THE TENSILE PROPERTIES OF MALLEABLES.

annealing. The graphs show the amount by which the properties of the specimen ground before annealing exceeds the corresponding properties of the turned specimens.

The tests were conducted on one lot of metal, all annealed together. Therefore they correspond to one set of decarburising conditions only. Since decarburisation varies, as the annealing conditions vary, another series of investigations was made to determine the changes in properties in iron of initially similar composition by variable decarburisation.

In Fig. 4 have been plotted the results of some 50 such tests on iron having from 2.40 to 2.60 per cent. carbon, 0.70 to 0.80 per cent. silicon before anneal, which correlate the tensile properties with the carbon content after annealing. The graph is plotted from average values. Individual tests depart considerably from the average, since small changes of carbon content in the hard affect the material much more than much larger variations due to decarburisation.

Figs. 3 and 4 serve to show that the final properties are relatively little affected by the decarburisation process. Being measured on surface metal, the elongation probably depends only in the carbon content near the surface and but little on the depth of decarburisation. The tensile properties are somewhat more consistently affected by decarburisation.

Decarburisation is controlled in practice by the character of the packing material. Perhaps it would be more accurate to say that the results in practice depend on the packing used, there being but little available information with regard to the action of packing.

The commercial packings depend for their activity chemically on the reduction of ferric oxide, Fe_2O_3, to FeO, ferrous oxide. It is not to be understood that they actually liberate oxygen on heating, as, for instance, potassium chlorate does.

Four Possible Reactions.

The process is a chemical reaction in which the oxygen never appears as such, but merely combines with carbon. Four reactions are possible depending upon the circumstances:—

$$3Fe_2O_3 + C = 2\,Fe_3O_4 + CO$$
$$6Fe_2O_3 + C = 4\,Fe_3O_4 + CO_2$$
$$Fe_3O_4 + C = 3\,Fe\,O + CO$$
$$2Fe_3O_4 + C = 6\,Fe\,O + CO_2$$

The two reactions $FeO+C=Fe+CO$ and $2\,FeO+C=2\,Fe+CO_2$ are theoretically possible, but occur only under unusual circumstances, if at all.

The fact that the analysis of packings is expressed as a rule in terms of the Fe_2O_3, FeO, SiO_2 and possibly Al_2O_3 and other oxides has given rise to the unfortunate conception that they are mix-

TABLE I.—*Composition of Typical Packings.*

	FeO	Fe_2O_3	MnO	SiO_2	Al_2O_3
Ore	.00	91.43		8.57	
Pot scale ..	37.10	53.11		9.79	
Roll scale ..	61.47	31.99		6.54	
Squeezer scale ..	69.74	9.34	.80	14.95	5.17
Slag	28.80	1.16	4.85	50.42	14.77

TABLE II.—*Approximate Analyses of Packings.*

Source.	Pot scale.	Roll scale.	Squeezer scale.	Slag.
Fe	4.04	6.88	—	—
FeO	54.36	57.33	58.49	38.25
Fe_2O_3	9.04	5.97	3.14	1.03
MnO	—	—	1.50	3.03
SiO_2	21.02	26.16	24.92	43.60
Al_2O_3 .. .. .. (and undetermined).	11.54	9.66	11.95	14.09

Probable Ultimate Composition of Above.

	Per cent.	Per cent.	Per cent.	Per cent.
Fe	4.04	6.88	—	—
FeO	23.40	31.34	21.00	12.60
Fe_2O_3	—	5.97	—	1.00
$FeO)_2\,SiO_2$	40.90	—	56.90	—
$(Fe_2O_3)_2\,(SiO_2)_3$ ..	14.10	—	5.40	—
$(FeO)_3\,(SiO_2)_2$ ..	—	27.91	—	—
$FeO\,SiO_2$	—	—	—	45.20
$Fe_2O_3\,(SiO_2)_3$ ..	—	—	—	5.40
Various inert silicates by difference ..	17.56	27.90	16.70	35.80

tures of two oxides of iron with other inert oxides. As a matter of fact all packings in use, as distinguished from the raw packing, have become complex silicates. The practical annealer unconsciously acts on this knowledge where he limits his additions of roll scale, or other raw material, to small amounts at any one time, for a packing con-

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taining any large amount of free oxides is not a workable material.

The raw material from which packing is built up usually is roll scale or squeezer scale from rolling mills, pot scale (the oxide from the outer surface of the annealing pots after they are drawn from the furnace) or air furnace slag. Iron ore was once used, but probably is now obsolete. Table I. shows the composition in the usual terms of these several materials.

It should be understood, however, that only the first three are actually oxides. Ore is nearly pure ferric oxide contaminated somewhat with silicon minerals. Pot scale is a more or less impure magnetic oxide, Fe_3O_4, contaminated by sand adhering to the pots. Roll scale is magnetic, and ferrous oxide originally nearly pure, but contaminated in gathering it up and shipping. Squeezer scale is a mixture of basic silicates of iron and manganese with some iron oxides, mainly ferrous oxide dissolved in bibasic ferrous silicates. Slag is a neutral silicate contaminated with fused brick, etc.

It will be seen that the packings contain little free oxide, and are mainly silicates. The ferrous silicates are incapable of reduction to metallic iron under the usual annealing conditions, so that the oxygen for oxidising the carbon is derived primarily from the reduction or Fe_2O_3 to FeO, although ferrous oxide of pot and roll scale may enter into the reaction.

The relative amounts of carbon monoxide and carbon dioxide formed depend on the temperature and the packing being used. With the materials and temperature of commercial practice the ratio is fairly constant; approximately 12½ per cent. of the carbon being burned to CO_2, the remainder to CO.

The principal reaction involved, assuming Fe_2O_3 as the active medium, corresponds to the equation:—

$$9\ Fe_2O_3 + 8\ C = 18\ FeO + 7\ CO + CO_2.$$

The actual mechanism of the decarburising reaction forms an interesting, though complex, problem in physical chemistry. The oxidation of the carbon in the iron and reduction of the packing are accomplished by the gas surrounding both. To be operative, a system must be chosen so that at the temperature and pressure in the annealing pot the gas phase present is such that the reactions:—

$$Fe_3C + CO_2 = 2\ CO + 3\ Fe$$
$$Fe_2O_3 + CO = 2\ FeO + CO_2$$
$$FeO + CO = Fe + CO_2$$

can all proceed from left to right. In other words, the system must be one in which a ratio of CO to CO_2 can be maintained which will at the same time oxidise Fe_3C, reduce Fe_2O_3, and reduce FeO.

If the relative concentration of CO and CO_2 be such that the first reaction ceases or reverses no decarburisation will occur. If the reaction is initiated it would soon cease, due to the conversion of all available CO_2 to CO, unless the second reaction continuously reconverted CO to CO_2. If the last reaction reversed, the iron of the casting would be oxidised, in addition to the carbon in the consequent scaling. Only some of the more usual reactions have been considered, there being a number of others possible between the components of such a system.

Scientific investigations of the subject matter involved would be based on determinations of the composition of the gas phase in equilibrium with the several oxides of iron and carbon concerned, and a location as to temperature and concentration corresponding to the reactions proceeding in the desired directions.

Practical solutions under working conditions were found long before the theoretical aspects were known to exist. For instance, the third reaction is what eliminated many materials from practical use by trial, it being found that they scaled the product. The maintenance of the second reaction was the cause of the old practice of rusting packing with salammoniac solution, which usually is not necessary, etc.

Decarburisation is generally favoured by a high temperature, at any rate up to 815 or 870 deg., although it begins and continues at much lower temperatures. In air it proceeds at measurable rates at 592 or 658 deg. in F_2O_3 at around 704 deg., and in FeO at around 760 deg.

Decarburisation is promoted also by enlarging the surface of contact of the gas with packing and castings and by free circulation of the gas.

There remains still another consequence of the heat treatment to be considered. All metals are made up of a system of crystalline grains. The size of these grains is profoundly affected by heat treatment. Each specimen has a particular grain structure, characteristic of each particular temperature. Just how a given temperature will affect grain growth depends on matters connected with the chemical composition of the piece and its previous history as to mechanical stresses and heat treatments.

The entire subject is still but dimly understood, and the applications of the laws of grain growth to malleable have been investigated only slightly and by a few observers. By analogy with other metals it seems certain that differences of grain size and of the properties of the grain boundaries have an important bearing on the resulting product.

The British Foundry Exhibition.

The arrangements for an Exhibition illustrative of the foundry industry, to be held in Birmingham in June, 1922, on the occasion of the Annual Convention of the Institution of British Foundrymen, are well advanced, and the number of entries is already sufficient to ensure success. The Exhibition will be in the Bingley Hall and will be open for a week. It will be the first of its kind to be held in this country and will be laid out on comprehensive lines so as to show the present condition of the foundry industry in all its branches and the latest appliances used. In addition to the Convention there will be a number of technical conferences in connection with the Exhibition itself. Patronage and support of the Exhibition have been promised by the Institution of British Foundrymen, the British Cast Iron Research Association, the American Foundrymen's Association, the Belgian Association of Foundrymen, the Association of Foundrymen (France), the National Light Castings Association, the National Ironfounders Employers' Federation, the Malleable Ironfounders' Association, the Cast Iron Pipe Association, the South Staffordshire Ironfounders' Association, the Cast Iron Holloware Manufacturers' Association, the Stove Grate Manufacturers' Association, the Iron and Steel Institute, the Staffordshire Iron and Steel Institute, the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Automobile Engineers, the British Engineers' Association, the Institute of Metals, the Birmingham Association of Mechanical Engineers, the British Non-Ferrous Metals Research Association, the British Refractories Research Association, the British Commercial Gas Association, the National Union of Foundry Workers, the Brassfounders Employers' Association, and the British Aluminium Holloware Manufacturers' Association. Gratifying proof of interest in the Exhibition has been received from America, France and Belgium.

Application for permission to German subjects to exhibit was made by the German Ambassador on behalf of the Verein-Deutscher Eisengiessereien, the headquarters of which are at Düsseldorf. It was represented that the foundry industry of Germany is large and comprehensive, and comprises as many as 600 foundries. Although there was every desire to make the Exhibition thoroughly international, the Committee, after careful consideration, have decided to refuse the application. The space already is nearly all taken, and it was felt that the inclusion of German exhibitors might make it necessary to refuse applications from our late Allies or neutral countries. Further, the Cast Iron Research Association did not feel at liberty to take the lead in the admission of German subjects while the policy of exclusion has not yet been reversed by the Iron and Steel Institute and other British technical and learned societies.

Institution of British Foundrymen.

LONDON BRANCH.

The first meeting of the session was held at the rooms of the Institution of Marine Engineers, Minories, London, on October 13, the Branch-President, Mr. H. O. Slater, in the chair.

THE BRANCH-PRESIDENT, in opening the proceedings, said that a vacancy had occurred on the Council through the resignation of Mr. Gaskin, owing to ill-health, and he proposed that Col. Cheesewright be elected to fill the vacancy.

This proposition was seconded by Mr. T. D. Robertson, and carried unanimously.

THE BRANCH-PRESIDENT then read his Presidential Address.

GENTLEMEN,—

In opening the first meeting of the session as Branch-President my first duty is to extend a hearty welcome to all members and visitors, though it has been customary to leave this until the end. It is sometimes well to depart from ordinary formal procedure, for it is obvious that that has been one of our greatest faults. Our meetings have been too "cold"; members and visitors simply attending, listening to the lecture and discussion, and departing without even an introduction. That should be our first reform. Some hold high and influential positions, others quite humble ones, but by the mere fact of their attending the meetings of the Branch indicates a keen interest in their craft and the engineering industry and entitles them to the respect of all.

Undoubtedly the London Branch is at a disadvantage by the fact that it spreads over such a large area. Members seldom come into contact with one another except at the meetings, and there are quite a number who cannot attend except on very special occasions. As a Branch we must set out to know one another.

On entering the Branch 11 years ago with the object of making up the number and possibly gleaning some information that would elucidate some of the apparent mysteries of the iron-founders' craft, from both the practical and scientific standpoint, it was evident the Association possessed men of capacity on both sides. Undoubtedly my ideas and membership have been justified. The information gained, coupled with practical experience and observations, have been helpful in opening up a clearer vision of foundry matters and made me more interested and observant than perhaps I would otherwise have been.

Even in the greatest distress a member can be happy in the knowledge that he has the whole of the members of the Institution at his back from whom he can seek advice in a confidential manner. That being one reason we should, as members, do our utmost to develop the social side of the Institution so as to know whom to approach for advice on a particular subject. Through being in constant touch with the members so long, I am convinced that even in the London Branch there are men capable of giving sound advice on every detail of foundry procedure, practice, and problems.

The Control of Buying and Selling.

Every foundry foreman should know, without reference to the cost office, exactly what his productive and non-productive cost are. He should be aware of the purchase price of his materials and have their selection, for he knows the quality necessary for any class of work he has on hand. It is one of the most essential items of foundry efficiency. This is asserted with all due respect to buyers, very few of whom have any real knowledge of the pitfalls of foundry life.

Except for large firms, who have their buying departments entirely independent from other parts of the works, it is usual to find one man controlling both buying and selling prices. Here is the incentive for procuring inferior material, very often unsuitable for the purpose for which it is required, and when this procedure does not turn out satisfactorily the foundry foreman has to shoulder the burden, and if he complains that the defects arise from cheap or unsuitable material, the climax resembles the explosion of a "Jack Johnson."

It frequently occurs that for the sake of trade a fairly large order would be accepted at a low selling price, irrespective of whether it be intricate or heavy work. In this case, too, the commercial man can cover himself, for the onus of cheap production falls on the foundry foreman.

Cheap production may cause misunderstanding or even serious trouble between employer and employee, and unless the foreman can prove his case with actual figures, it is difficult for him to retain his position. It thus becomes essential that any foreman should carefully scrutinise all charges and itemise all branches of production. The establishment of an accurate system places the foreman in a position to co-operate in ascertaining the real cause of a trouble or a high cost.

By having figures and facts at hand, opponents are less likely to take advantage, and shop matters run smoother than if ignorance prevails on one side. It may be thought that these conclusions are merely theoretical, but they are based on personal experience, and have induced me to advocate incessantly the better education of the foundryman in commercial matters. For the successful management of a foundry one must be well equipped commercially, practically, and temperamentally.

The Objects of the Institution.

The objects of the Institution as laid down in the Rules are rather vague, the wording of Rule 2 can mean anything, and could be interpreted so as to restrict our activities. My conception of the objects of the Institution were rather more definite and more inclined to follow the impression one would get from the crest, "Science Hand in Hand with Labour." I believe that the founders of the Institution could see that the fusion of the two elements were necessary to national efficiency in the foundry industry, and no doubt realised that they had a real and difficult problem to surmount for even to-day there are still suspicions lurking in the minds of many as to possibility of reconciling the two, and there certainly exists a section who believe them to be diametrically opposed.

It is here where the real work and interest of the Institution lies, in bridging the gulf that exists. This can only be accomplished by getting into contact with all concerned in the foundry industry and bringing to the top those that would otherwise remain in the mire. To accomplish this scientific and practical papers cannot be depended upon, but it must also be demonstrated by the institution of better conditions in foundry life, for obviously there is still much to be desired in this direction

The Apprenticeship Problem.

It has been customary in the past for Branch-Presidents to refer to the vexing apprenticeship problem. Instead of propounding personal views, it may serve a more useful purpose to outline the successful scheme operating at the works of Messrs. J. and E. Hall, of Dartford, who have kindly consented to its publication.

The scheme, which is diagrammatically outlined in Fig. I., follows in some respects the published reports of the Continental organisations, in so much as it incorporates a pre-apprenticeship period.

Knowing the British boy as I do, this pre-apprenticeship period should attract boys to the foundry instead of driving them away, as is said to be the case on the Continent. An interesting feature is the fact that during this period the boys attend for one day each week at the local technical institute, there to follow up such elementary subjects as lead up to the science of engineering.

Before signing any indentures the boys are required to pass an examination, and, additionally, other suitable boys may sit, but if successful they are required to spend six months in the works before being bound.

Each boy thus selected will be bound by indentures as an apprentice to a trade and start upon a regular five years' course. During the first year the boy receives a varied instruction in one department, and attends technical classes for two evenings each week. After the first annual examination those boys who receive the highest number of marks are awarded a "D" certificate,

which enables them to undergo a higher training during their second year, including one day per week at the technical school. Other apprentices continue with their shop training, supplemented by evening classes.

Similarly, after the second year's training, the more successful apprentices who gain "C" certificates will be allowed two days per week at the local or some other approved technical college. The third year's examination is for a "B" certificate, the gaining of which entitles the holder to be graded "Engineering Pupil," and still higher studies are planned for his advancement.

Briefly, the basic difference between the system devised by Messrs. J. and E. Hall and most others is that a bright youth with ambition is not destined to become a fully-fledged skilled workman on completing his time, but is fitted to assume an important position in the technical direction of an engineering works.

One great step towards bridging that gulf would be the stabilising of employment, unemployment is most demoralising; it has a great tendency to make bad men worse and good men bad, energetic

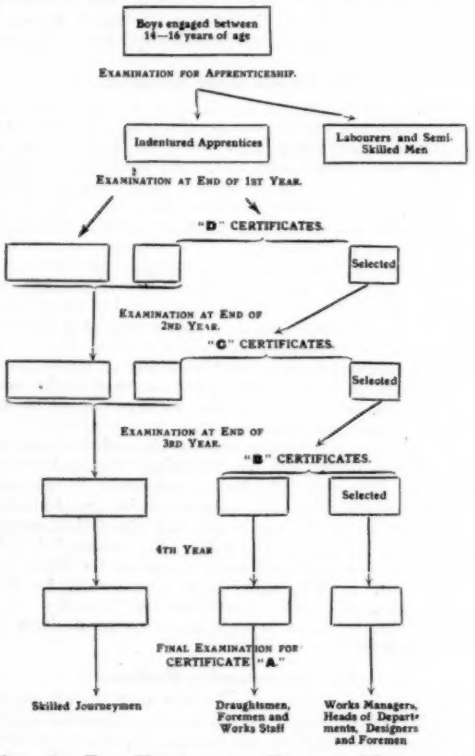

FIG. 1.—THE EDUCATIONAL TREE OF MESSRS. J. & E. HALL, OF DARTFORD.

men apathetic, and to rob them of the incentive of becoming good parents and trustworthy citizens. We cannot afford to lose the interest of these men if we are to keep our place in the world markets, for if we lose the interest of good skilled workmen we lose national wealth.

Gentlemen, I am exceedingly proud this evening, for never since the inception of the London Branch has a meeting been honoured with the presence of a past and present President of the Institution on its opening night, and I sincerely trust that the Branch will be encouraged thereby and make good progress during the coming session.

Co-operation of Members.

MR. A. WILLIS moved a vote of thanks to the Branch-President for his Address. He was very pleased to see Mr. Slater in the Presidential Chair, because he was one of the oldest members of the Institution, and had been one of its most active members. He had been very much struck by a remark in the Address, to the effect that it was useless to expect the Council to do the entire work; they could not do anything without the co-operation and help of the members. He remembered, during his term of office as Secretary, that the Council decided to do certain things; they sent out notices and endeavoured to get the members to say whether they would take part, but they did not meet with much success, because the members did not co-operate. He hoped Mr. Slater would be able to infuse some enthusiasm and interest into the members on the social side as well as on the lecture side, so that they would have greater success during the present session, as obviously there was likely to be less trouble in the labour world. There had been, during his term of office as Secretary, two coal strikes, two railway strikes, three or four moulders' strikes, and so forth, and they had had to put off various functions because of these incidents. In connection with the organisation of visits to works, which was a good idea, during the last two years they had had to drop off to a certain extent owing to the excessive railway fares. However, he thought that they should now be on the upward grade.

MR. A. R. BARTLETT, in seconding, said the Address was of very great interest, and he had brought out points which, he was sure, had interested all those present. As Mr. Willis had said, the point which affected them most was the question of their organisation in London; they wanted to get the co-operation of every member as far as possible. He agreed with Mr. Willis in his remarks about the lack of attention on the part of the members. He was rather disappointed at the meeting that evening; there should have been more, especially having regard to the fact that they had the President of the Institution present.

THE BRANCH-PRESIDENT, in thanking the members, said that they must go farther back than the present. If he had worked enthusiastically for the Institution he could see in the Institution another way, for those interested in the welfare of the industry, of helping towards better conditions. What he meant by going further back was that he had had the good fortune of starting in the foundry under Mr. Ellis. Mr. Ellis was a very enthusiastic man, and it was during his time if anything went wrong he was given good advice, and that was a principle which every foundry foreman should follow; they must not use coercion, but must persuade a lad to do the right thing, and if he inadvertently, or even mischievously, did wrong, they must correct him in a fatherly way. He hoped, when he vacated the office of President, the membership would be twice as large as at the present time, and that the meetings would also be very enthusiastic. He was going to try to recover some of the enthusiasm which Mr. Willis had said had been lost. He had taken on the Secretaryship when they were absolutely at their lowest ebb, and he felt that he (Mr. Willis) must take the credit for any success with which the Branch has met.

He then called upon the President (Mr. Oliver Stubbs) to address the members.

The Presidential Discussion.

MR. OLIVER STUBBS said he realised the difficulty they had in the London Branch in getting good meetings, owing to the wide area over which the members were spread, but if they only got a small number, who were sincere in the work they were doing, their efforts would not be in vain. He would like to associate himself with the President's remarks with regard to Mr. Willis. He had met Mr. Willis on many occasions in connection with Council work, and he had certainly always been very struck with his enthusiasm and his sincerity. He thought they would agree that the work they were now setting out to do was of the utmost importance, and there were, to his mind, many questions upon which they could dwell with advantage. If he were to offer them a word of advice, it would be to this effect, that whatever they did in their Branches, they must not make their Papers and discussions of such a nature that they were going to cut out the man who was working in the foundry and so stifle that criticism and exchange of opinions which, to his mind, had been the foundation and the upbringing of the Institution. They must encourage by all means discussion from all their members. He believed that the best work of the Institution was to make the humblest member feel that he was of the utmost importance to the success of the Branch. They

should discuss questions that were relative to the success of the foundry business. The British Cast Iron Research Association should deal with the more scientific side of the industry, because there was no getting away from the fact that they were only going to be employed by their employer so long as they were able to keep his confidence and show him a return for the services for which he was paying them. Dealing with the smaller number of apprentices entering the foundry nowadays as compared with the past, he suggested that the members should consider in their own Branch what were the reasons that they were not attracting the youths to the foundry as they did in the past. The foundry was looked upon as a dirty place. At the same time, it was a very important industry, and they were not making the apprentices to-day in anything like the proportion required to carry on the industry. The question of getting more members to the meetings of the London Branch had also been referred to. He was bound to tell the members of the Branch, however, that they had just as good members in that Branch as any other. He had borne testimony at the Convention at Blackpool to the very efficient manner in which one of their members, Mr. Robertson, had read Mr. Elliott's Paper on Electric Furnaces. If they had men of that calibre among them it was their own fault if they did not make their Branch a success, but every member must feel that he was personally responsible for doing something to make it a success. It was no good saying, "Don't you think it was a rotten meeting?" without saying to themselves, "How much have I done towards making the meeting a success?" They must all carry their fair share of the work of the Branch, and he was convinced that if they did, they were going to have in London a very much bigger Branch than they had in the past. Continuing, he said he wished to refer to the action of Colonel Cheesewright, who had very generously and kindly offered that if any members of any of the Branches of the Institution, who were subscribers to the official organ, unfortunately, should be in want of employment, provided their subscriptions were not in arrears, he would be pleased to give them four free insertions of an advertisement in THE FOUNDRY TRADE JOURNAL. He (Mr. Stubbs) did not want the members to lose sight of this opportunity. He had an idea that many firms of ironfounders in the country had not been supporting the Institution as they should have done. He believed they were all agreed that the Institution was the means of training foundry foremen and managers, and they were doing so to the benefit of those who were fortunate enough to employ them afterwards, and he felt that foundry employers should give them more support. He had much pleasure in handing to the President a nomination, duly proposed and signed, for a subscribing firm, which, he believed, was the first received by the London Branch. He referred to the Rodney Foundry Company, Limited. That was only one, and a good many of them, if tactfully approached, would follow their lead.

The BRANCH-PRESIDENT proposed a vote of thanks to Mr. Stubbs, the President of the Institution, for attending the meeting.

MR. ELLIS (a past-president) seconded, and commented on the hard work involved in carrying out the duties of the Presidency. There had been a danger, it seemed to him at times during recent years, of the Institution getting rather too academic. An enormous number of papers were read at the Branches and at the Institution Conference, and they all seemed to tend too much towards the scientific aspect, whilst the moulders who had not had any education in science sometimes wondered what the speakers were talking about. He felt quite certain that that was the case even that evening, and there were some of them who were moulders purely and simply and had not had an opportunity of studying the higher branches of their craft, although they were deeply interested in them. He was certain that they could rely upon the President, during his term of office, to raise the status of the foundryman, and all papers, if they were to be scientific, must be in some way applicable directly to the foundry, so that the average foundryman could grasp what the scientist was trying to teach him.

MR. STUBBS, acknowledging the vote of thanks, expressed the hope that as the result of that meeting the London Branch would become very much stronger. His whole aim and object was to encourage the Branches in their work, because if the war had taught us nothing else, it was that the time had come when we should mix with one another much more than had been the case in the past. Another thing it had taught was the usefulness of cast iron; owing to the difficulty experienced in getting non-ferrous metals, they had learned a wonderful lot, and to the foundrymen of this country they were largely indebted.

A Simple Foundry Production Chart.

By O. BERTOYA.

A very simple and easy method of keeping track of foundry orders is embodied in the chart shown below. Its usefulness lies in the fact that it enables the production executive to see at a glance how a given order is progressing and whether deliveries are being kept to schedule.

The chart is made to represent a monthly period but it may cover any number of days required provided it does not become inconveniently large. The days are plotted vertically, and the order numbers are filled in horizontally at a suitable spacing. Each group of thin lines shows the number of castings which must be made and delivered against each order every month. Thus the odd-numbered lines 1, 3, 5, etc., are production lines, and the even-numbered lines 2, 4, 6, etc., delivery lines. They are so drawn that although of equal length they are proportional to the number of castings required each month by making the scale to which they must correspond, fit in, in each case.

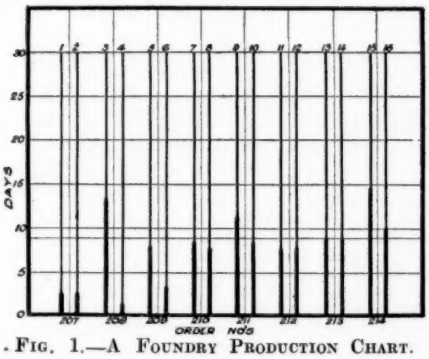

FIG. 1.—A FOUNDRY PRODUCTION CHART.

Thus, if order 207 must be delivered at the rate of 3,000 castings monthly, the scale adopted could be 1 in. equals 100 castings. Order 208, on the other hand, may call for 150 off in the same period. The scale would then be 1 in. equals five castings, and so forth.

As the various jobs are put into production and deliveries commence, the respective quantities cast and dispatched during the day are entered up on to the chart, from shop or stores record, by thickening over the thin lines with black ink for a length proportional to these quantities. Referring to the chart, it is shown that in the case of order 207 out of 3,000 castings roughly 300 have been delivered. Order 208 shows that approximately 80 have been cast, but only 35 dispatched.

Supposing that on the ninth of the month it is required to know how the various orders stand. By drawing a line across the chart all the necessary information may be at once obtained. It is clear, for instance, that orders 207, 209, 210 and 212 have been under-produced and under-delivered; orders 208 and 211 have been over-produced but under-delivered; order 213 is to schedule, but order 214 has both been over-produced and over-delivered.

The necessary instructions can then at once be given. Work on 208 and 214 must be stopped for awhile, and others pushed forward by amounts which may be determined by reference to the chart. The chart does not require much expenditure of time in being kept up to date, and may be easily drawn out on a large piece of paper pinned to the wall. The chart described above, although not suitable for jobbing orders, will be found invaluable in dealing with repetition work.

XUM

Trade Talk.

MESSRS. N. PEARSON & COMPANY, machinery merchants, etc., have removed to 83, Pall Mall, London, S.W.1.

THE OFFICES of the Institute of Transport have been removed to 15, Savoy Street, Victoria Embankment, W.C.2.

MR. A. E. LEFEVER, metal agent, etc., has removed to 37, International Exchange, Edmund Street, Birmingham.

ENGLISH ELECTRIC AND SIEMENS SUPPLIES, LIMITED, have removed their offices to 38, Upper Thames Street, London, E.C.4.

A DECREE has been published at Rio de Janeiro authorising the grant of a concession to an Anglo-Brazilian steel syndicate.

THE SECOND "Imperial College" of Science and Technology dinner, being a gathering of old students, is to be held at the Trocadero Restaurant, London, on November 24.

SKELTON, CORBITT & COMPANY, LIMITED, Sheffield Grate Works, Rotherham, have appointed Mr. J. Hemmens, 5, Codrington Road, Bishopston, Bristol, as their agent for the South-Western Counties.

THE WORKS of the Llanelly Foundry and Engineering Company, Limited, which are being erected adjacent to the Llanelly Steel Works, are nearing completion. The directors of the two concerns are associated.

THE NEW DE-TINNING WORKS at Llanelly of the Welsh Metals Extraction Company, Limited, will be ready to start in full operation when conditions become more normal. The works are the second of this kind in the town.

THE 1921-22 SESSION of the Institute of Electrical Engineers (Western Centre) was inaugurated on November 7, at the South Wales Institute of Engineers, Cardiff, when Mr. A. C. MacWhirter delivered his inaugural address.

THE OPENING MEETING of the session of the Liverpool Sub-Centre of the North Western Centre of the Institution of Electrical Engineers was held on November 7, in the Liverpool University, when Mr. G. H. Nisbett delivered his chairman's address.

MR. G. BATTY, of Sheffield, who last year spent six months in touring American steel works, recently lectured on his experiences at a meeting of the Sheffield Association of Metallurgists and Metallurgical Chemists. Mr. P. B. Henshaw presided.

THE NEWMAN-ANDREW COMPANY, 26, Cortlandt Street, New York, the United States branch of Jno. Hy. Andrew & Company, Limited, Toledo Steel Works, Sheffield, have appointed Mr. M. A. Green as manager of their tool steel department.

MR. DANIEL SHARPE has been appointed general manager of Foundry, Plant, & Machinery, Limited, which company has been formed to purchase the British rights of the Bardsley & Piper sand-throwing machine, with offices at 28, Royal Exchange Square, Glasgow.

THE SECOND meeting of the twenty-ninth session of the West of Scotland Iron and Steel Institute, was held in the Royal Technical College, Glasgow, on Friday last, when Mr. H. Etchells read a Paper on "The Present Status of Electric Furnaces in Steel Making."

MR. N. R. GLASS, manager of the Balto-British Shipyard at Reval, has just returned from a visit to Moscow, where he signed a contract with the Soviet Government under which the company undertakes the repair of 1,000 locomotives of the Russian railways during the next five years.

A LECTURE on "Elevating and Conveying Machinery" was recently given by Mr. H. Davies, at the Montgomery Hall, Sheffield. The lecture was under the auspices of the Sheffield branch of the Association of Engineering and Shipbuilding Draughtsmen, and Mr. J. W. Cusworth was in the chair.

THE OUTPUT of Lorraine iron ore reached 585,000 tons in August, as compared with 553,375 in July. The low value of the mark has compelled the Germans to manage without Spanish and Swedish ores, and to turn their attention to Lorraine. Their orders for October have exceeded 200,000 tons.

SEVEN VESSELS were launched on the Tyne during last month, totalling 28,923 tons net, as compared with six vessels, of 12,470 tons, in October last year. From January 1 to October 31, 55 vessels, of 171,061 tons, were launched, as against 68 vessels and 182,307 tons in the corresponding period last year.

THE MONTHLY MEETING of the Wolverhampton Branch of the Birmingham Metallurgical Society was held on November 9, Dr. T. J. Murray being in the chair. A paper on the "Testing of Metals" was read by Mr. H. S. Heathcote, M.Sc., F.I.C., chief research chemist to Rudge Whitworth, Limited.

THE GEARED turbine steamer, "City of Tokio," built by Messrs. Craig, Taylor, Limited, Thornaby Shipbuilding Yard, Stockton-on-Tees, has just been taken to sea for her official trial trip. The vessel is considerably the largest ever launched at Stockton, and has been built for the Ellerman Lines, Limited.

A FINE record for the production of pig-iron is reported by the Newcastle Steel Works (N.S.W.). In one week its No. 2 blast-furnace produced 3,715 tons. For the four weeks ended August 17 the Company's total production of pig-iron was 23,000 tons. The open-hearth department produced 21,000 tons of steel.

IN CONNECTION with the Sheffield Association of Metallurgists and Metallurgical Chemists, papers will be read at the forthcoming Tuesday night meetings at the Royal Victoria Station Hotel as follows:—November 22, Mr. J. N. Kilby, on "Basic Open Hearth Practice"; November 29, Mr. C. C. Sumpter, on "Surface Hardening."

CHRISTMAS, HULBERT & WALTERS, LIMITED, of Caxton House, Westminster, S.W.1, have during the last few weeks obtained several contracts, including gas-producing plant for South Wales and "Insley" gravity concrete placing plant for London and the Midlands, whilst several large lease contracts have been obtained for "Blaw" steel forms.

MR. BALDWIN (President of the Board of Trade), in a written reply to Major Kelley (Rotherham—C.U.) in regard to the amounts and value of imports and exports of iron and steel for the month of September, states that the imports amounted to 206,127 tons of a value of £1,830,000, and exports of United Kingdom manufacture to 133,324 tons of a value of £4,082,000.

THE OUTPUT of the Belfast shipyards for the ten months ended October 31 shows an increase compared with the same period of 1920. During the ten months ten steamers and two motor vessels, with an aggregate tonnage of 79,300, were launched, as against eleven steamers, one motor vessel, and six oil barges, aggregating 74,300 tons, between January 1 and October 31, 1920.

THE COMMITTEE appointed by the National Union of Manufacturers to deal with the matter of Trade Boards has arranged to give evidence before Lord Cave's Committee at Montagu House on November 23. Mr. W. Ivey-Rogers, chairman of the committee, will introduce the witnesses, who will be Mr. Arthur E. Beck, Mr. H. D. Jackson, Mr. Gordon T. Harwood Stamper, Mr. W. Hyman, and Mr. Ashley Ward.

AT A MEETING of the council of the Society of Consulting Marine Engineers and Ship Surveyors, held on November 8, Mr. J. Blackett, of Messrs. Jos. Blackett & Son, Philpot Lane, London, E.C., was nominated for the office of president in succession to Sir Fortescue Flannery, Bart., M.P., and Mr. C. E. Smith (West Hartlepool) and Mr. J. Denholm Young (Liverpool) were nominated as vice-presidents.

JOHN LE BOUTILLIER, LIMITED, Colonial House, 17, Tooley Street, London, S.E.1, British agents for the Magnesite Company, Limited, of Basel, Switzerland, will have control of the sales organisation of the Eglinton Magnesite Brick Company, Limited. The company have taken over the office of the Eglinton Silica Brick Company, Limited, at 45, Renfield Street, Glasgow, for the convenience of Scotch consumers.

THE WEST OF ENGLAND AND SOUTH WALES IRON, METAL, AND WASTE ASSOCIATION have received an intimation from the Ministry of Labour that their request for the withdrawal of the general waste reclamation trade from the operation of the Trade Boards Acts could not be acceded to, as there was no evidence that since the application of the Acts adequate machinery had come into existence to maintain a reasonable level of wages throughout the trade.

SPEAKING AT THE first meeting of the session of the Cleveland Institution of Engineers, Major H. G. Scott, the retiring president, expressed his feelings of pride and satisfaction in addressing the members for the first time in their new headquarters. The annual report and balance-sheet were submitted by Mr. W. H. Burns, secretary. During the session 64 new members were added, bringing the total to 408, and it was stated that with those admitted that night the actual membership would be 433.

AT THE first meeting of the Federation of British Industries Committee on Trade Depression, the Government's new plans for stimulating trade and relieving unemployment were considered. The committee were of opinion that these plans could only be regarded as limited in their incidence and of a temporary character, and attached the greatest importance to two lines of policy, which are receiving the close attention of the Federation:—(1) The reduction of costs; and (2) Relief of industry from the burden of taxation.

DECLINING A SUGGESTION conveyed by Mr. Howard Gritten, M.P. for the Hartlepools, from local ironworkers that unemployment benefit due to them should be paid to the local iron industry to enable it to keep them in employment, the Premier points out if the principle were admitted a very large number of firms would be able to qualify for grants, and if not actually in difficulties, would naturally claim a share, with the result there would soon be something like a universal system of subsidising wages from State funds.

IRON AND STEEL MARKETS.

Pig-iron.

Production in the pig-iron industry continues disappointing in tonnage, only a limited proportion of smelting plants being in actual operation or likely to resume work until a substantially increased demand is assured. In the West of Scotland there are only 18 furnaces in blast, 16 being engaegd in the production of foundry qualities and two hematite. The demand from the foundries is so restricted, however, that producers cannot dispose of all the output, and it is reported that some makers have under consideration the question of again putting furnaces out of operation. In the Midlands pig-iron prices have again shown a weaker tendency, Derbyshire forge having been sold at £5 10s. at furnaces, while Northamptonshire foundry can be had at even lower rates. Midland foundries are still not absorbing much, nor is there any demand for forge iron to speak of. The cuts in prices have done something to lessen foreign competition, and although deliveries are being made against old contracts, new business is not of large dimensions. The recent cuts in Cleveland pig have, so far, had little effect in stimulating demand, and business is consequently slow. It is now clearly realised that Tees-side ironmasters have gone to the extreme limit of concession in prices possible in the existing conditions, and unless further reductions in railway transport charges and fuel costs can be secured it is hopeless to expect makers to again lower quotations. In the meantime the Cleveland ironmasters are presenting a strong case to the railway managers for a reduction of the railway rates on minerals, etc., which leads to a renewal of the hope that by a reduction of the costs of production smelters may be enabled to bring down their prices to a competitive level. For the present, however, buyers are only purchasing iron from hand to-mouth, and it would be useless to blow in more furnaces, because the available output is ample for all requirements In North Lincolnshire Messrs. Lysaghts are lighting up two furnaces, presumably for the production of basic, but on Tees-side the number in blast remains at twenty. Prices also are unchanged, No. 1 being quoted 115s. No. 3 Cleveland G.M.B., 110s., No. 4 foundry 105s., No. 4 forge 100s., and mottled and white 97s. 6d. per ton. Fair quantities of East Coast hematite are still being delivered to South Wales, but Sheffield is taking little or none, and local makers are very keen for orders. The nominal price of mixed numbers is 120s., but business can be placed as low as 115s. per ton, and 117s. 6d. for No. 1. The decision of the West Coast Ironmasters' Association to reduce their quotations for ordinary hematite pig-iron to £6 15s. for mixed numbers, delivered Sheffield, has been received with satisfaction by consumers, but, so far, has had little stimulating effect upon business, either home or export.

Finished Iron.

Movements in the finished iron branches remain for the present as uneventful as previously recorded, many of the works being still with barren order books, while others have to be contented with operating on a much restricted scale. Even marked bar makers appear not to be quite so well supplied as they were, although they have a fair number of orders to carry on with, mostly for the Eastern export trade. The position of the Staffordshire makers of crown iron, however, is indicated by reports that the Association price of £14 10s. is not being adhered to. It is denied that members of the Association are cutting, but, in any case, outsiders are, and prices below £14 have been mentioned. There are great complaints, not only as to the difficulty of securing orders, which, when they are obtained, are only of "hand-to-mouth" size, but of the most unprofitable nature of the business. There is no improvement in connection with gas strip, but makers of high-grade finished iron are expecting to benefit by the new shipbuilding contracts as the work develops.

Ore.

There is very little life in the Tees-side foreign ore market, in which there are plenty of sellers of best rubio ore at 27s per ton, c.i.f., the most recent freight fixtures from Bilbao being 7s. 9d. prompt, and 8s. forward. Business, however, is extremely slow, and, indeed, consumers are reluctant to take deliveries of ore already bought. Only a few mines are now working in the native iron-ore industry, smelters, as a rule, holding extensive reserve stocks sufficient to keep the limited number of furnaces in blast in operation.

Tinplates.

The tone of the market is fairly good, but the reduction in the price of steel bars, together with the fact that wages are now stabilised on a lower basis, enables makers of tinplates to cut their prices to some extent for new business. For January onwards, 21s. basis is being freely quoted for approved specifications in coke finish, net cash, f.o.b., a moderate trade being reported at this figure. Prompt plates are in most demand, however, and for these 22s. to 22s. 6d. basis is generally asked. Wasters are in fair demand, and a few ordinary sizes are obtainable, 20s. 6d. f.o.b. being quoted for C.W., 20 by 14's, tin-lined and iron-hooped. Sellers are now asking up to 18s. 3d. f.o.b. for quarter wasters, for which there are buyers at 17s. 6d., f.o.b. Ternes are steady, heavy gauges being in demand.

Steel.

Although without material change at the moment, steel trade prospects are slowly improving, and there appears to be distinctly more optimistic views of a turn for the better in the early future. As far as Sheffield is concerned, however, developments are necessarily retarded by the present excessive costs of production and transport, prices having already fallen to a point which almost precludes any profitable return on makers' output, or encouragement to tender for contracts abroad with any confidence. Some encouragement is, however, to be derived from the increase in the volume of inquiries coming to hand, and if the resulting orders are only on a small scale, the bulk affords some assistance in keeping works from complete stagnation. Competition for any current orders is, of course, keen, and price cutting is reported in more than one department of the steel trade; indeed, it is freely rumoured that a definite break with the Associations on this matter is imminent, if not already accomplished. Among the branches now fairly well employed may be included the manufacture of railway wagons, of which an enormous number is required to replace the destruction of recent war-times. At present orders for new wagons are restricted by financial considerations, but, on the other hand, works are well employed on repairs, which, of course, absorb a large quantity of steel material in the process. The crucible and high-speed steelmakers are further depressed by the disclosure that the Government surplus discovered of high-speed and other crucible steel is nearer 2,000 than 1,000 tons. They are awaiting anxiously to hear a statement of the method of disposing of it.

Metals.

Copper.—The position in the standard copper market shows that the firmness previously reported is fully maintained, with increased strength of buying on forward account, especially for New Year deliveries. November was done at £67 5s. to £67 2s. 6d.; December, £67 5s. to £67 to £67 7s. 6d.; January, £67 15s. to £67 7s. 6d., closing with both cash and forward 10s. higher. Refined copper was also firmer, electrolytic and wire bars both ruling 20s. higher at £75 to £77 and £76 to £77 respectively. Closing prices.—Cash: Wednesday, £66; Thursday, £66 5s.; Friday, £66 10s.; Monday, £67; Tuesday, £66 15s. Three Months: Wednesday, £66 12s. 6d.; Thursday, £67; Friday, £67 5s.; Monday, £67 15s.; Tuesday, £67 12s. 6d.

Tin.—The week's markets for standard tin opened firm, latest advices from the East giving a fair turnover of metal sold at £160 15s. c.i.f. Consumptive demand on this side continues light, but the tone was steady, attention being chiefly concentrated on forward account, which closed on balance with a fractional decline. November was done at £158 10s. to £158; January, £159 5s.; February, £159 15s., with English ingots 5s. lower at £156 15s. New York, December-January was done at £161 5s., c.i.f. There was an increase of 142 tons in stocks in London, last week's total being given at 5,334 tons. Closing prices.—Cash: Wednesday, £157 5s.; Thursday, £156 7s. 6d.: Friday, £158; Monday, £157 12s. 6d.; Tuesday, £157 7s. 6d. Three Months: Wednesday, £159 5s.; Thursday, £158 12s. 6d.; Friday, £160; Monday, £159 12s. 6d.; Tuesday, £159 7s. 6d.

Spelter.—The market for this metal reports a steady demand on consumer's account, and with sellers reserved quotations showed an advance of 2s. 6d. for both near and forward positions. Closing prices.—Wednesday, £25 17s. 6d.: Thursday, £25 15s.; Friday, £26; Monday, £26 2s. 6d.; Tuesday, £26 5s.

Lead.—Business in soft foreign pig continues quietly steady, with a fair turnover in the week's markets. There was some forward buying, January dates being quoted £27 7s. 6d., and February £23 15s., with English qualities firm. English closing prices.—Wednesday, £25: Thursday, £25; Friday, £25: Monday, £25; Tuesday, £25 5s.

XUM

Personal.

THE late Mr. S. Tyzack, a director of W. Tyzack, Sons & Turner, Limited, left £30,932.

THE LATE MR. W. G. SMITH, principal of Messrs. William Smith & Company, Millhouses Wire Works, near Penistone, left £8,362.

MR. FRANK TATLOW, general manager of the Midland Railway, has been elected chairman of the General Managers' Conference for the year 1922.

MR. W. J. FIRTH has been elected joint managing director of the Grovesend Steel and Tinplate Company, Limited. The other managing director, Mr. H. Folland, is chairman of the company.

MR. F. BEST, of Thos. Firth & Sons, Limited, Sheffield, is at present on a business trip in New York in connection with the new sales arrangements for the company. He is accompanied by his son, Mr. F. A. Best.

MR. WM. BROWN, chairman of Wm. Simons & Company, Limited, shipbuilders, Renfrew, has been the recipient of a presentation from the officials and men in recognition of his long connection with the company.

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Company News.

Yorkshire Engine Company, Limited.—Dividend on the 5 per cent preference for years 1916 to 1919 inclusive.

Golconda Metal Company, Limited.—Capital £10,000 in 8,000 ordinary shares of £1, and 40,000 deferred shares of 1s.

Craigie Engineering Company, Limited. — Capital £1,500 in £1 shares. Registered office: 26, Elmbank Street, Glasgow.

Marshall Engineering Company, Limited. — Capital £250 in 1s. shares. Secretary: H. B. Browne. Registered office: 59-60, Chancery Lane, W.C.

Kerr, Stuart & Company, Limited. — Net profit, £33,459; brought forward, £577; available, £34,036; ordinary dividend, 2s. 1d. for year, less tax, £19,583; carried forward, £6,053.

Wayne Engineering and Equipment Company, Limited.—Capital £7,500 in £1 shares (2,500 10 per cent. cumulative preference). Registered office: 111-113, Great Portland Street, W.1.

Wake & Company, Limited.—Capital £25,000 in £1 shares (10,000 10 per cent. cumulative preference). Slag merchants. Registered office: Clarence Iron Works, Port Clarence, near Middlesbrough-on-Tees.

C. Waghorn, Limited.—Capital £3,000 in £1 shares. Brass founders. Directors: C. Waghorn, J. Radcliffe, and J. Wade. Secretary: C. Waghorn. Registered office: Garfield Works, Well Lane, Halifax.

Charles A. Midgley & Company, Limited. — Capital £2,000 in £1 shares. Engineers. Directors: C. A. Midgley and A. Barnes. Secretary: C. A. Midgley. Registered office: Hastings House, Norfolk Street, Strand, W.C.2.

Seth Ormondroyd & Company, Limited. — Capital £2,000. Dealers in machinery, metals, iron and steel, etc. Directors: J. Ormondroyd (secretary) and A. Hudson. Registered office: Newall St., Manchester Road, Bradford.

United Engineers, Limited. — Profit, £418,556; brought forward, £192,109; reserves and written-off stocks, £467,480; interim ordinary dividend 10 per cent., less tax; preference dividend, 7 per cent., less tax, £15,313; carried forward, £26,290.

Hardy Patent Pick Company, Limited.—Brought forward, £12,594; net profit, £23,638; total £36,233; interest on debentures, £1,650; dividend on 7 per cent. preference, £2,100; ordinary dividend, 10 per cent., less tax, £7,000; depreciation of plant, etc., £8,000; depreciation of tools and patterns, £2,000; carry forward, £15,483.

Gazette.

THE BILSTON IRON SHEET & GALVANISING COMPANY, LIMITED, are being wound up voluntarily, with Mr. D. Whitehouse, Craven House, 121, Kingsway, London, W.C., as liquidator.

MR. W. H. KEETCH and ALICE MAUD TURNER, engineers, 90 and 92, East Street, Bedminster, Bristol, trading under the style of Keetch and Turner, have dissolved partnership. Alice Maud Turner continues.

MESSRS. W. H. PEASE and F. E. PRATTEN, engineers and machinery merchants, 8, Southampton Row, Bloomsbury, London, W.C., trading under the style of W. H. Pease, Pratten & Company, have dissolved partnership. Mr. W. H. Pease continues.

THE PARTNERSHIP heretofore subsisting between Messrs. G. Williams and H. Womersley, engineers, Rosa Works, and Ings Road, Wakefield, under the style of Williams and Womersley, has been dissolved. Mr. H. Womersley will continue the business.

THE PETITION of Bagshaw & Company and another for the compulsory winding up of W. S. Laycock, Limited, again came before Mr. Justice Astbury in the Companies Winding-up Court recently. Counsel for the company suggested that the petition should stand over again until last petition day of the present sittings, which was agreed to.

MESSRS. A. HAMMOND and F. A. BOTTOMLEY, engineers and merchants, 33, Mackenzie Street, Slough, Bucks, trading under the style of Hammond and Bottomley, have dissolved partnership. Mr. Hammond will in future carry on business at 83, Ladbroke Road, Notting Hill, and Mr. Bottomley will continue business on his own account at 33, Mackenzie Street, Slough.

DR. J. W. RICHARDS, Professor of Metallurgy at Lehigh University, died recently, aged 57. The deceased gentleman was born in Oldbury, and was taken to America when very young. In 1887, Dr. Richards was appointed assistant instructor in metallurgy and blowpiping at Lehigh University, and he served continuously at the University from that time to his death in the following positions: Instructor in metallurgy, mineralogy and blowpiping, 1890-1897; assistant professor, 1897-1903; professor of metallurgy, 1903-1921.